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EST. 1902

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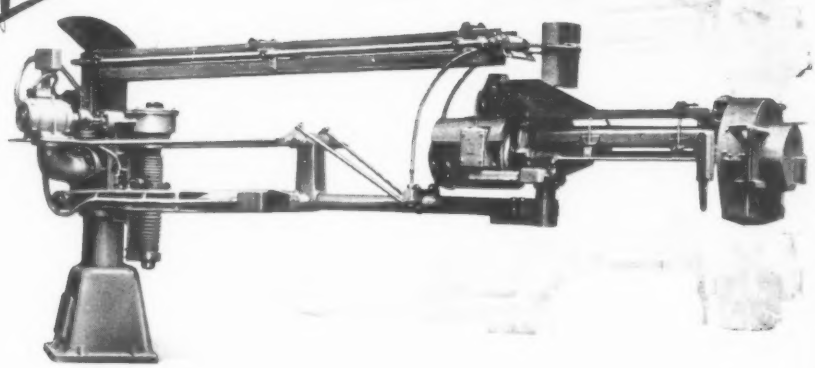
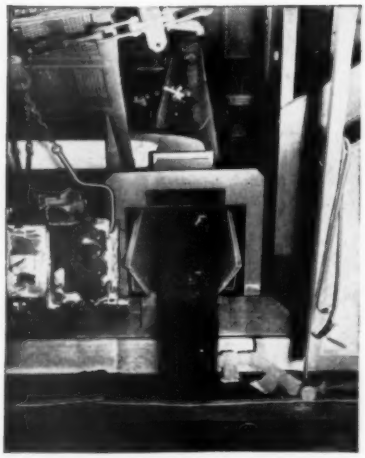


STATIONARY TYPE SANDSLINGER
with arm raising and lowering gear

Sandslinger

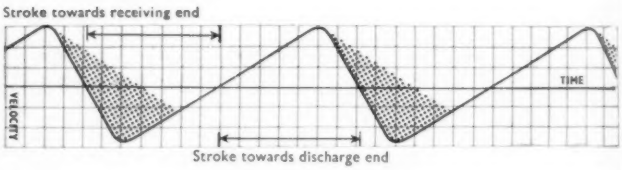
FOUNDRY PLANT & MACHINERY LTD
EGLINTON WORKS, COOK STREET
GLASGOW, C.5.



Shaker conveyor discharging scrap on to a similar conveyor. (The photographs reproduced in this advertisement are published by courtesy of Ford Motor Company Limited.)

Sand cores and risers from engine component castings fall on to a shaker conveyor which carries them to a rotary scrap breaker and sand separator.

Shaker conveyor showing type G 20 drive, driven by a 20 h.p. flywheel motor; this robust drive delivers high peaks of energy.



SHAKER CONVEYING

in a mechanised foundry

The Distington-Goodman shaker conveyor is not a jigger conveyor. Its troughs move in only one plane on ball-bearing rollers and propel material by variations in their rates of acceleration and deceleration (these are shown in the time-velocity curve above: the shaded areas represent the movement of material independent from the movement of the troughs).

Distington-Goodman shaker conveyors have been used for many years for loading and conveying coal and rock. Their robust all-steel construction makes them ideal for handling hot materials in foundries and cement clinker and sinter.

They are easily extended and contracted and can be made self-loading from stock heaps. Lines of troughing can be made to deviate through angles up to 90°. Conveying capacity depends upon several factors but would normally exceed 60 t.p.h. on the level.

DISTINGTON ENGINEERING COMPANY LIMITED

WORKINGTON · CUMBERLAND · ENGLAND

DB.22

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- FAST BAKING YET TOLERANT
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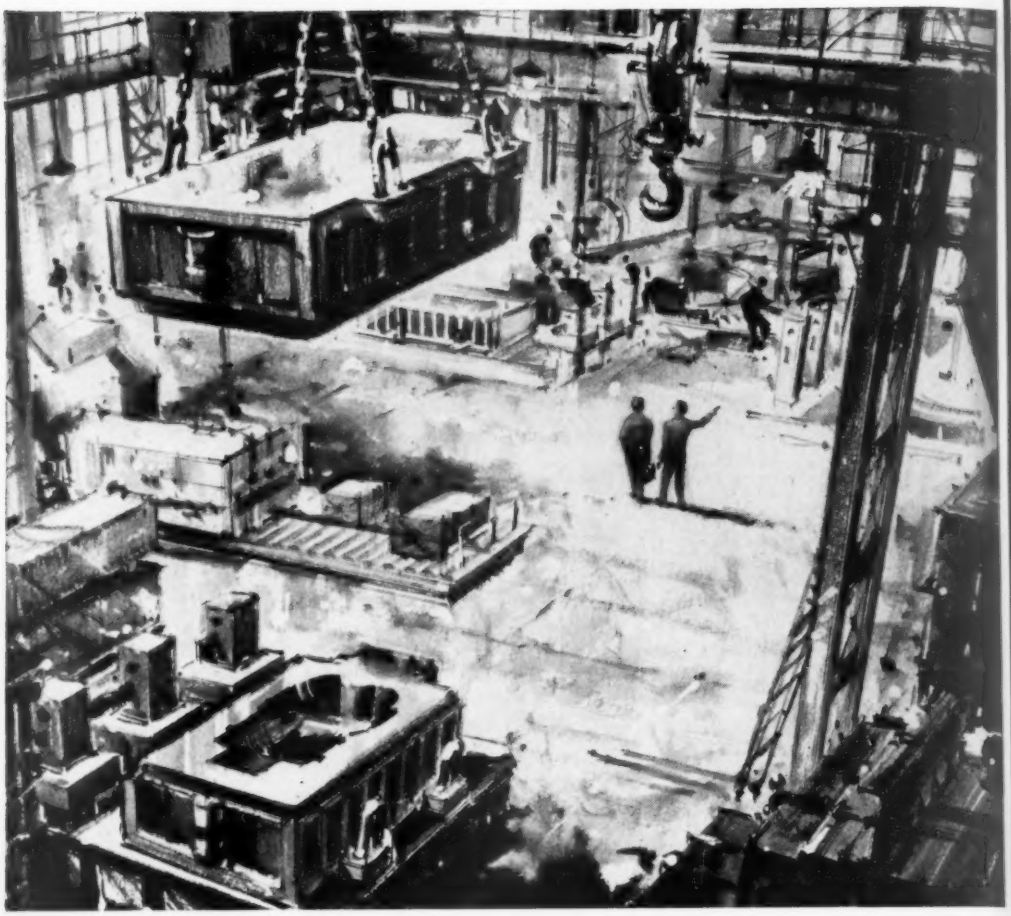
Our representative in your area will be pleased to demonstrate—
May we put him in touch with you?

HARMARK FOUNDRY SUPPLIES

Manufactured by

HARBOROUGH CONSTRUCTION CO·LTD·MARKET HARBOROUGH



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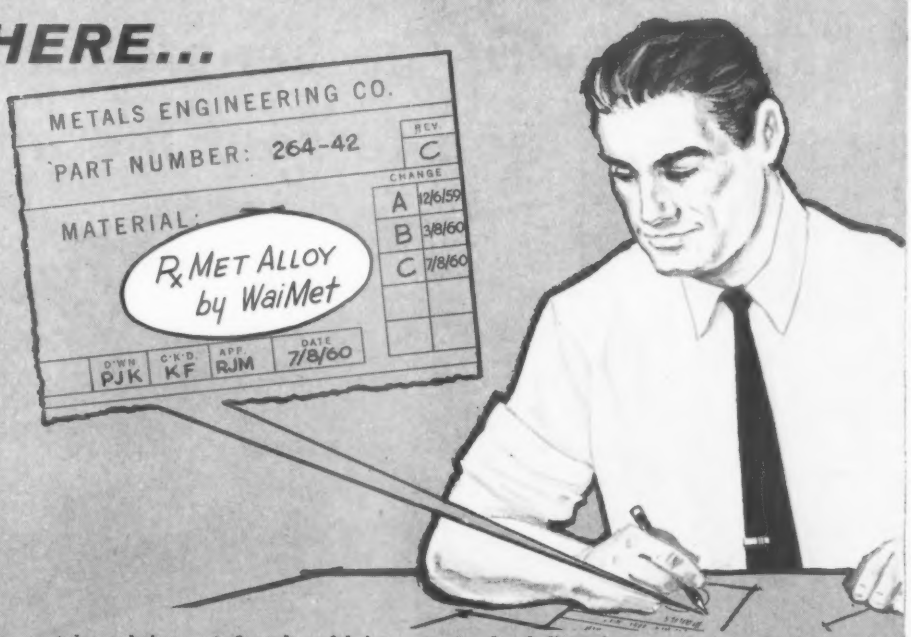

Wherever metals are being cast, forged, or fabricated, the important factor of reliability can be assured by specifying R_xMet brand alloys. Whether we ship shot for making castings, billets for forging, or special welding rod, the R_xMet label on the alloy means more consistent performance in the finished product.

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TOOL STEELS • STAINLESS STEELS
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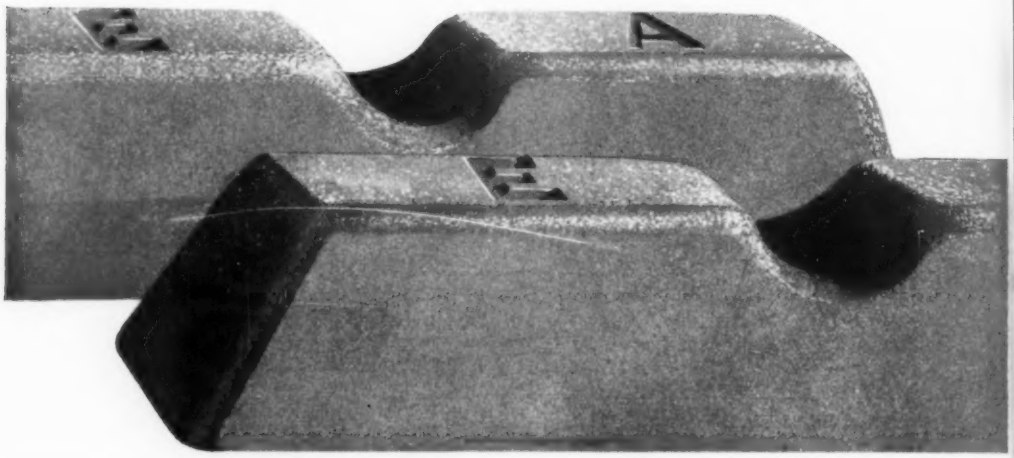

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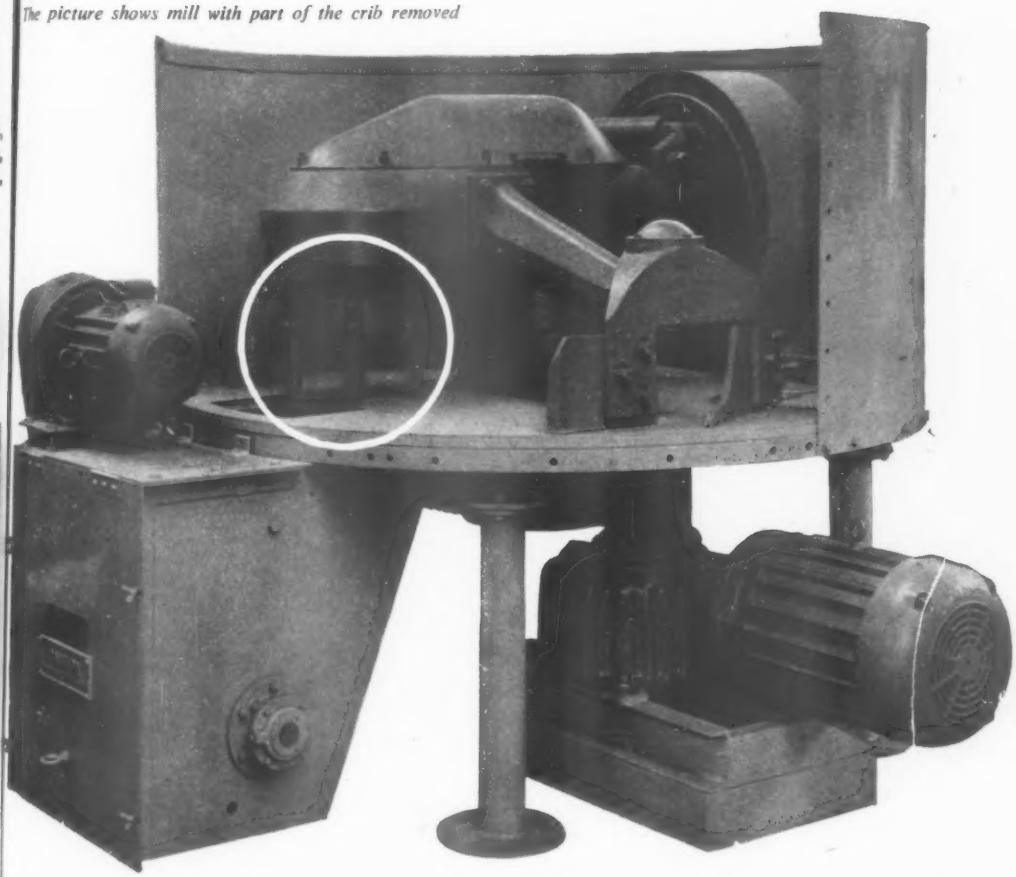
THIS NEW MIXING MILL, WITH THE POSITIVELY DRIVEN STIRRERS, IS ESPECIALLY SUITABLE FOR THE PREPARATION OF CO_2 SAND.

The picture shows mill with part of the crib removed



Built in England by

PNEULEC LIMITED, SMETHWICK, Nr. BIRMINGHAM

The most efficient wet type Spark Arresters are without doubt

Roper

Because Roper productions are more than efficient they are reliable in operation

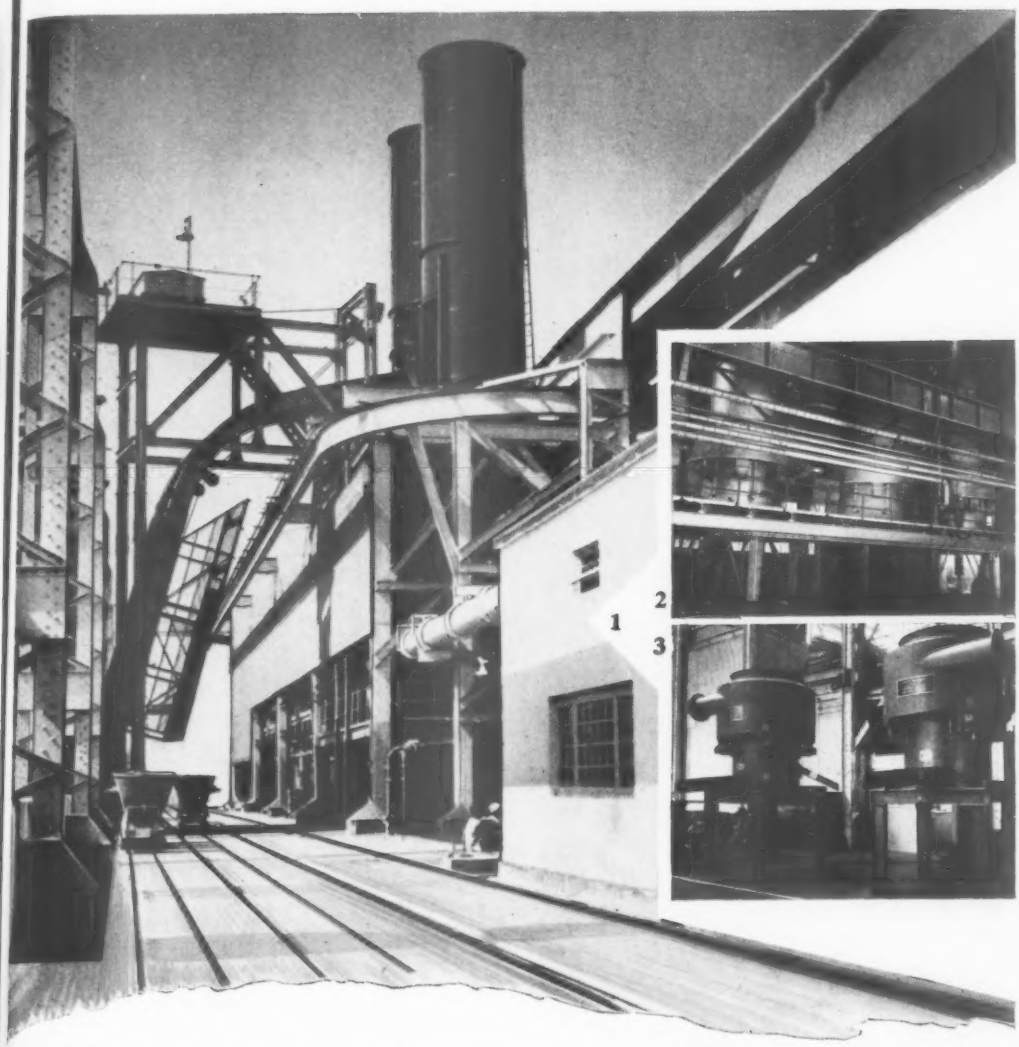
Illustration on left, a Wet type Spark Arrester with Inspection Platform serving a 17 ton per hour Cupola.

And on right shows a Spark and Dust Suppressor with a Spray Jet giving a double water curtain.

E. A. ROPER & CO. LTD

Photographs by courtesy of BILSTON FOUNDRIES LTD.

FOUNDRY EQUIPMENT ENGINEERS
KEIGHLEY YORKSHIRE
Tel: Keighley 4215 6 Grams: "Climax" Keighley



All in the day's work

There is no cupola too large or too small for Incandescent Foundry Plant Division. From the cupolette with an output of 15 cwt an hour to the largest cupolas in Europe (35 tons an hour) there is an Incandescent-Whiting cupola tailored to your needs.

Photographs :

(1) Two 20-ton-per-hour cupolas with swivel charger bridging a rail track. (Indian Iron & Steel Co. Ltd.)

(2) Three 35-ton-per-hour cupolas with automatic air weight control and wet dust arresters. (Guest Keen Iron & Steel Co. Ltd.)

(3) Bottom sections of two 4-ton-per-hour cupolas in the works.

INCANDESCENT FOUNDRY PLANT

THE INCANDESCENT HEAT CO. LTD.

SMETHWICK · ENGLAND

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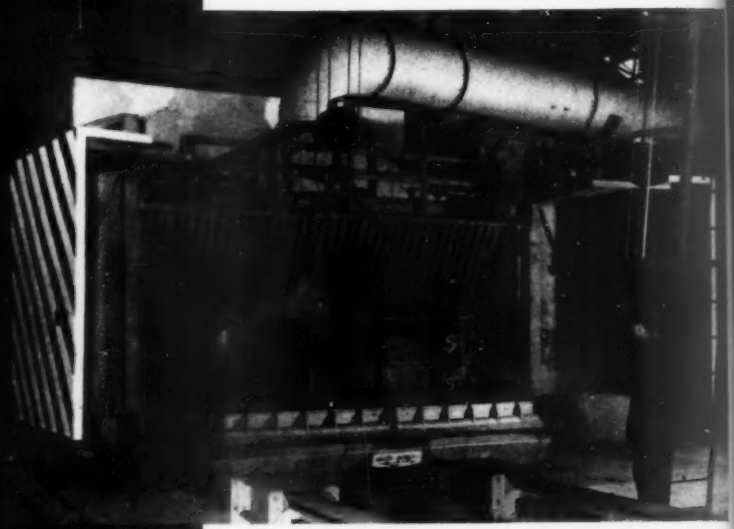
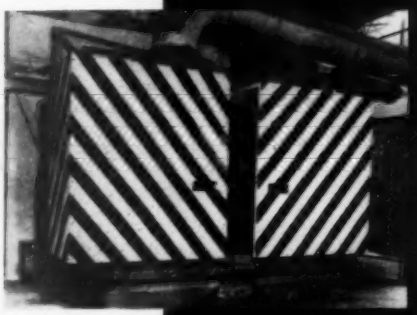
HOLMES-SCHNEIBLE MULTI-WASH SYSTEM

for dust collection and control



The photographs show the doors in both the open and closed positions.



An interesting feature of the Holmes-Schneible Multi-Wash installation in the steel foundry of English Steel Castings Corporation Limited are the hydro-pneumatically operated doors enclosing the shake-out hood. These doors which were designed in co-operation with English Steel Castings Corporation Limited, have been very successful in operation and have resulted in a considerable saving of exhaust volume necessary at the shake-out position. The installation is completed by two size 138 type 'JC' collectors, a dewatering tank, hoods on the sand preparation plant, fan and ducting.

For full details write for a copy of Publication No. 80/23

W. C. **HOLMES** & CO. LTD.

Gas Cleaning Division, Turnbridge, Huddersfield

Telephones: Huddersfield 5280
London: Victoria 9971
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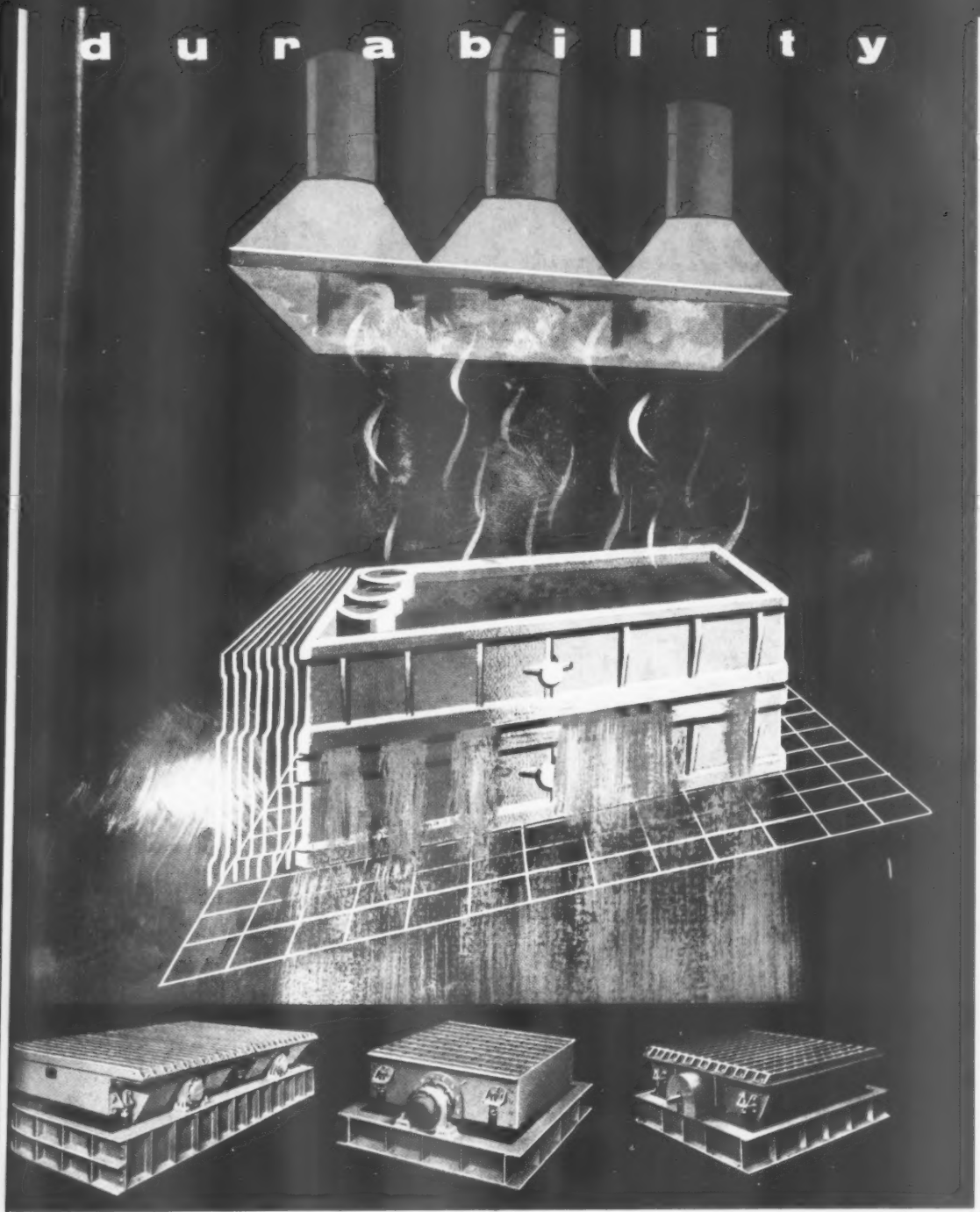

Solid ribbed hot-rolled steel sections re-inforced externally enable these boxes to resist the roughest usage for the maximum period . . . prolonged if a Shakeout Machine is used.

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Many Foundrymen think Wet Spark Arresters are a recent development and because of troubles experienced with some installations, usually caused through bad design, they tend to regard them with suspicion.

We are proud that FORD MOTOR CO. selected **TITAN** Wet Spark Arresters for the **4 TITAN** 30 ton per hour Hot Blast Cupolas which we installed in their new Thames Foundry, the most modern in Europe.

These are illustrated, the second Cupola from the left is " blowing " —note the complete absence of dark smoke, sure proof of efficiency.

Photo completely untouched taken during normal operating conditions.

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Fordath are sole manufacturers and distributors in the United Kingdom under exclusive licence from Reichhold Chemie A.G. Switzerland, who are proprietors of British Patent Nos. 653,530 and 761,035

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THE FORDATH ENGINEERING COMPANY LIMITED, who are the suppliers of the well-known COROVIT range of cold-setting binders (consisting mainly of processed drying and semi-drying oils) and accelerators, desire to draw the attention of foundries to United Kingdom Patent Nos. 653,530 and 761,035, the property of Reichhold Chemie A.G. of Switzerland, under which Fordath have exclusive rights.

The Patents are concerned with the use of certain accelerators, in conjunction with drying oils in foundry sand. The claims of the patents are so framed that, where the patents are infringed, it is the foundry that infringes (and so is liable for any damages that are involved) and not the seller of the accelerator, nor even the seller of the drying oil.

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THE FORDATH ENGINEERING CO. LTD., BRANDON WAY, WEST BROMWICH, STAFFORDSHIRE
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FOCUS ON 'FULBOND'

Nº 11

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CMF 66

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Samuel Osborn & Co., Limited, achieve greater accuracy, soundness and improved surface finish by Shell Moulding a wide variety of castings in Stainless, Acid and Heat Resisting Steels, as well as other High Alloy, Tool, Die and Low Carbon Steels.

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Photograph by courtesy of Samuel Osborn & Co., Limited, Sheffield.

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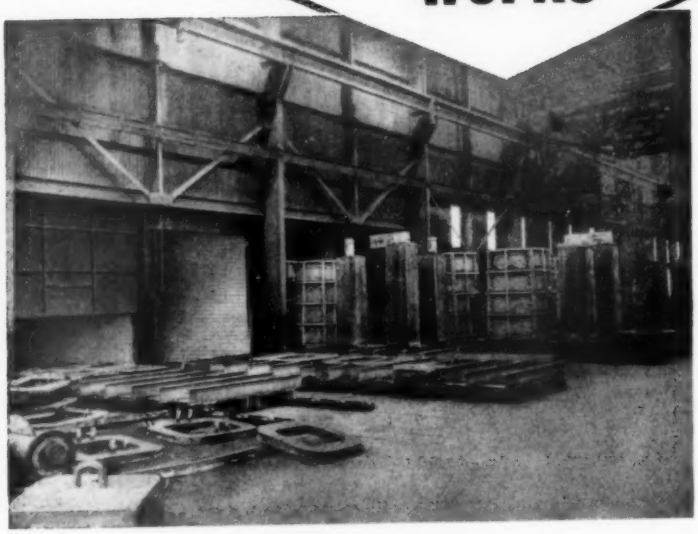

In addition to the important Iscon contract for which "NEWSTAD" Equipment also includes Mould Drying Stoves, Core Drying Stoves, and Ladle Drying and Preheating equipment "NEWSTAD" products are also used by the Brightside Foundry & Engineering Co. Ltd., in their new mould foundry at Eccles-field. The high efficiency of "NEWSTAD" ingot mould stoves is proved by the fact that more than three of these stoves have been supplied to any one other make.

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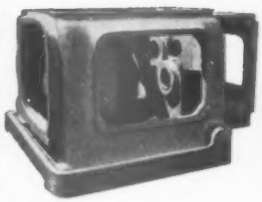
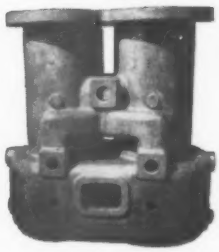
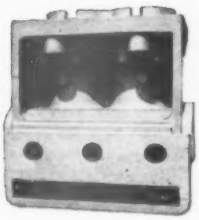
All these intricate iron castings were produced by Robert Cort & Son Ltd., Reading, using CO_2 for core and mould hardening and Isopropyl Alcohol as the base for the flash dressing. You can get this sort of result simply and consistently in your foundry too.







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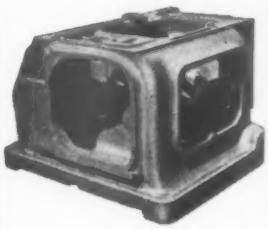

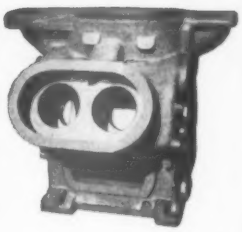

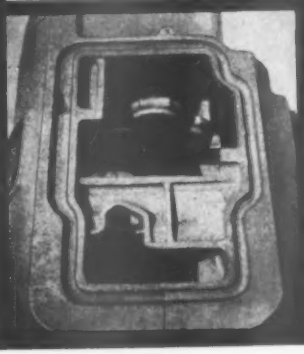

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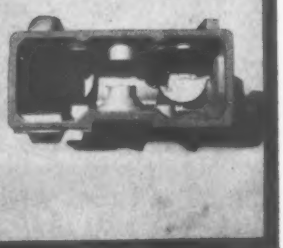

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FOR HIGH DUTY CASTINGS

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Photograph by courtesy of THE WESTINGHOUSE BRAKE & SIGNAL COMPANY LTD., Chippenham.

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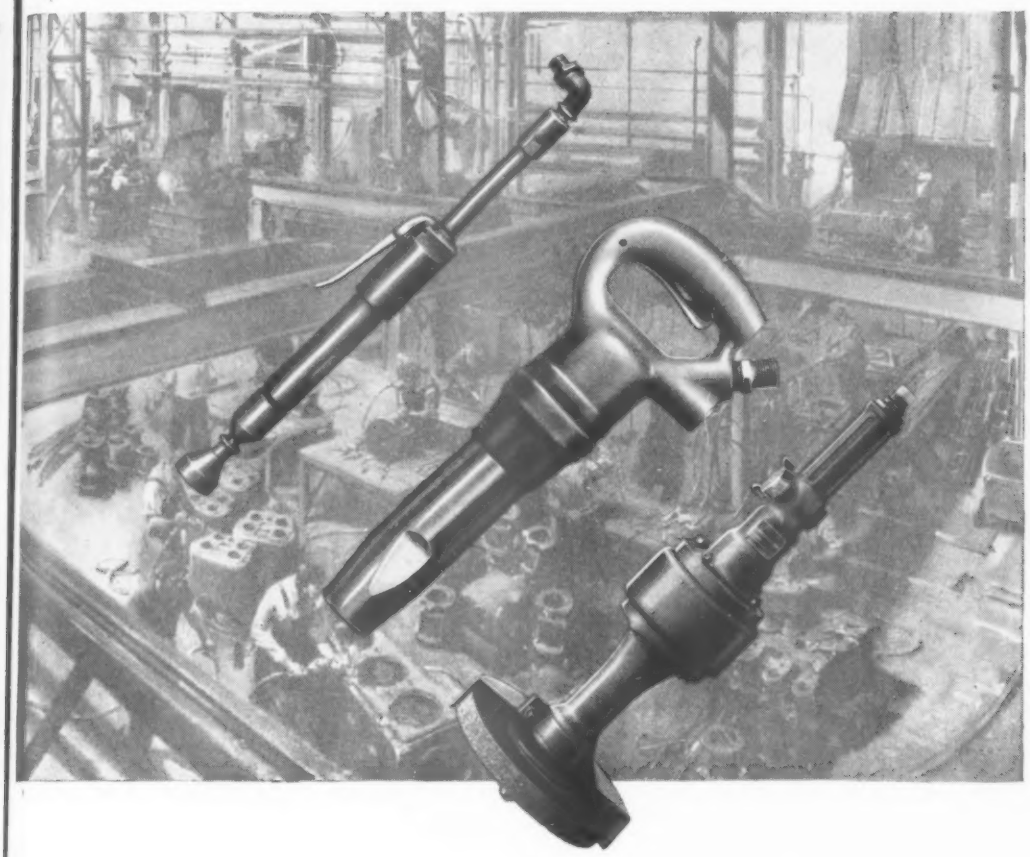

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Illustrated are (left to right) the BR3 Rammer, DX5 Chipping Hammer and the GR3 Grinder. For full details write for Publication No. 407 *T.E.*

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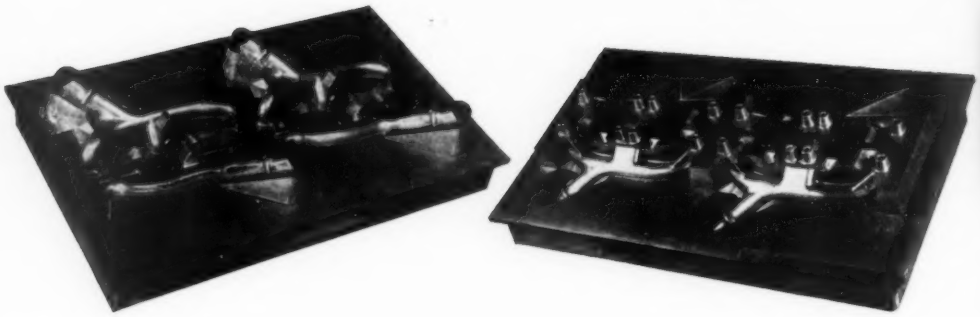

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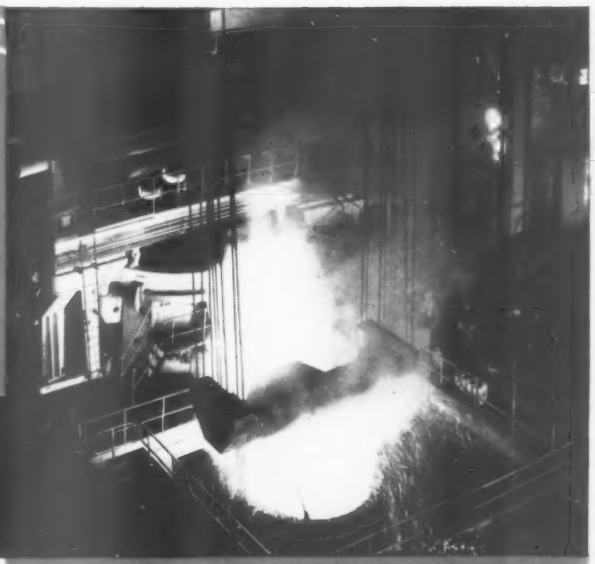
Official statistics show increase in output of tonnage electric steel



Tapping one of the two 19 ft. arc furnaces at Round Oak Steel Works Limited.

No. 1 Round Oak Steel Works Ltd.

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In the accompanying graph, electric steel output figures for 1956-1959 inclusive are plotted for the district comprising Staffordshire, Shropshire, Worcestershire and Warwickshire. The figures are taken from official statistics published jointly by the Iron & Steel Board and the British Iron & Steel Federation.

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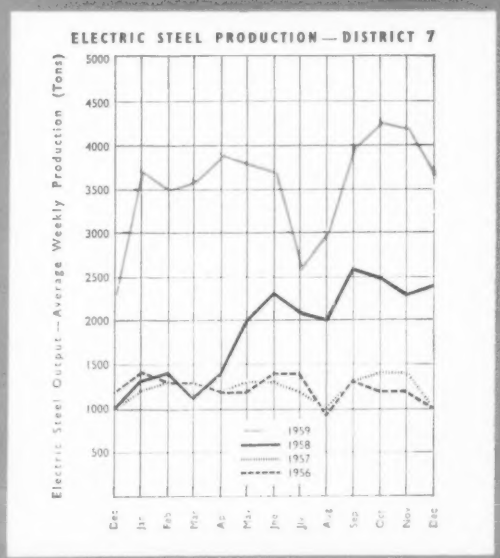

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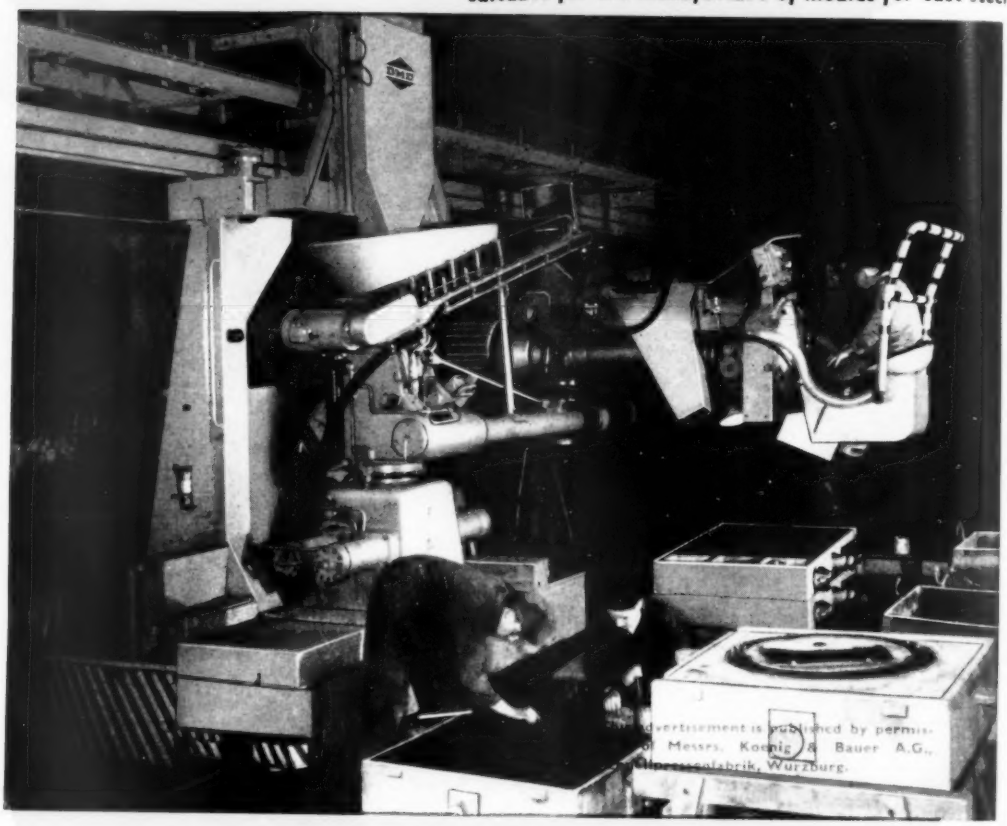

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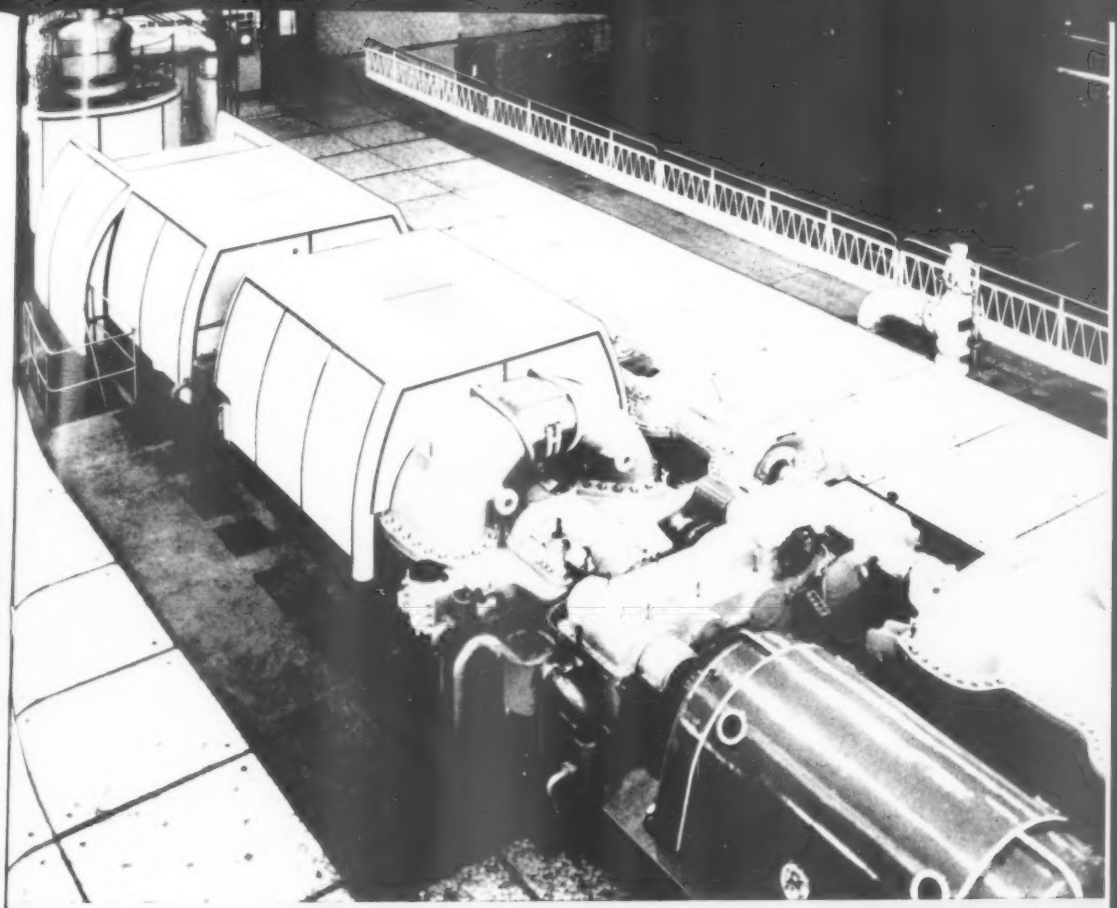

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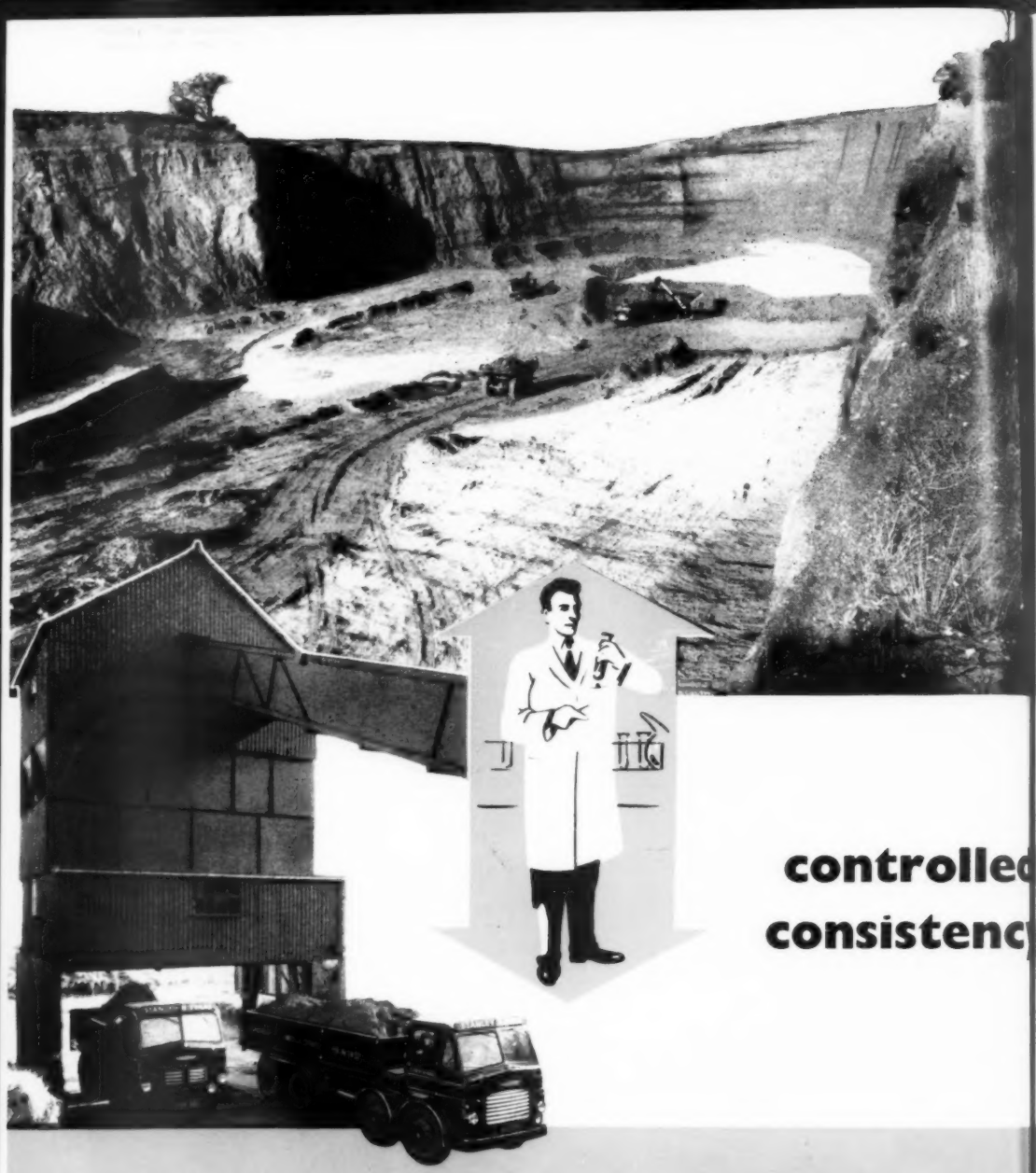

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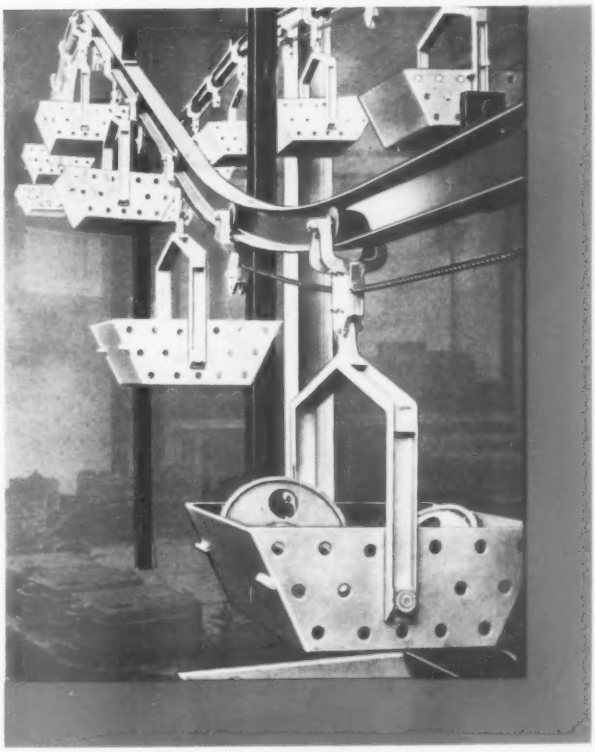

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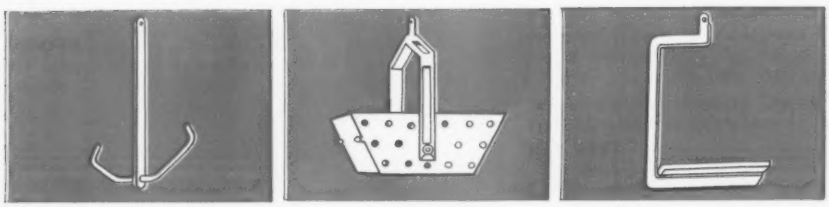

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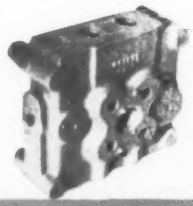

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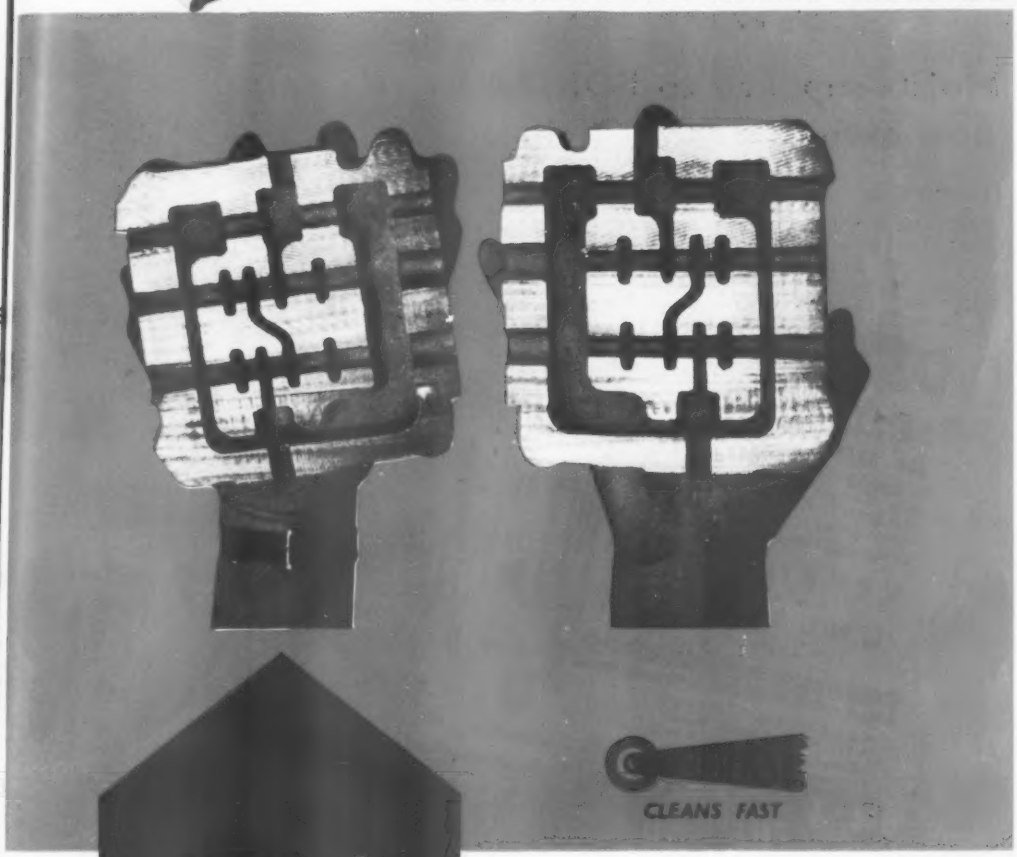

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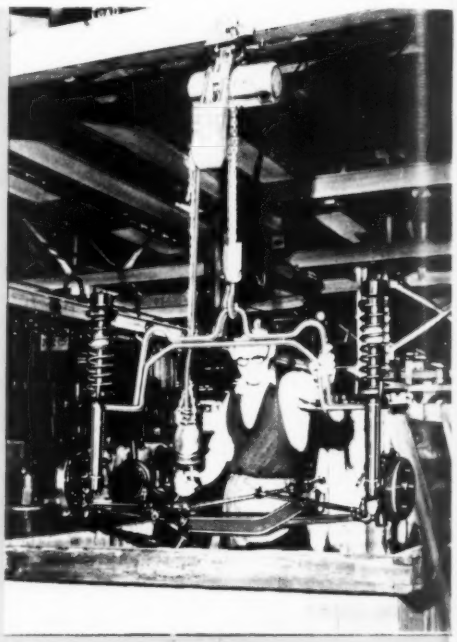

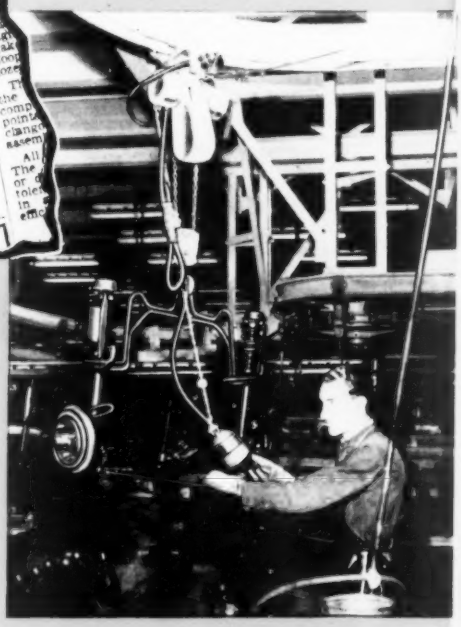

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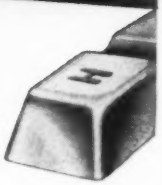

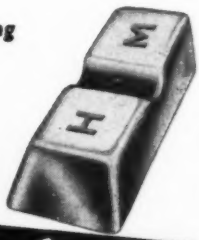

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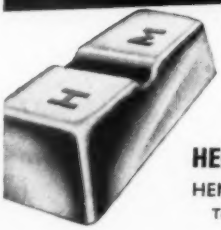

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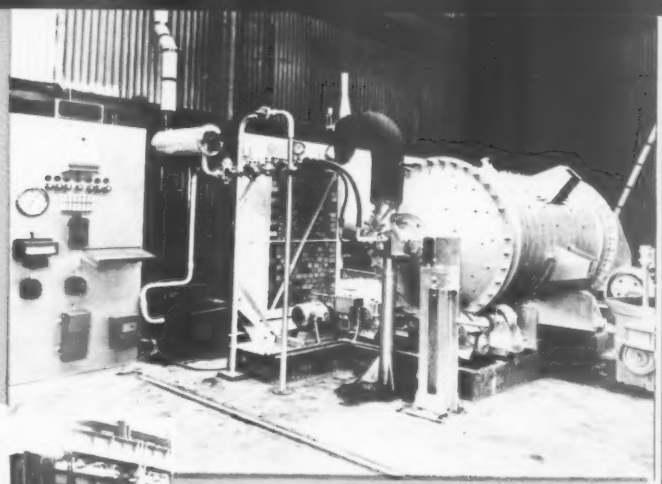

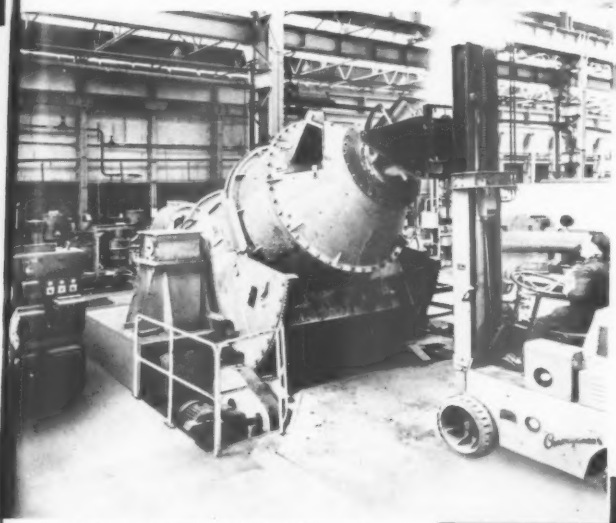

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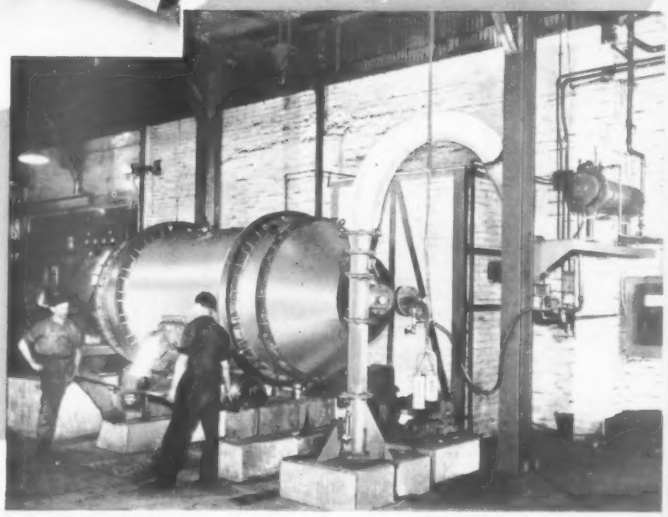

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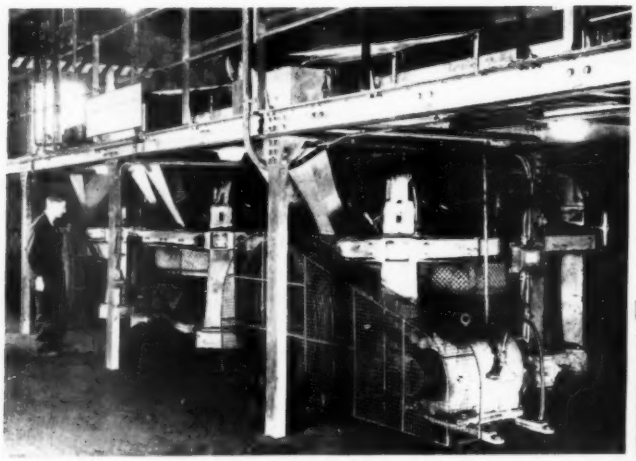

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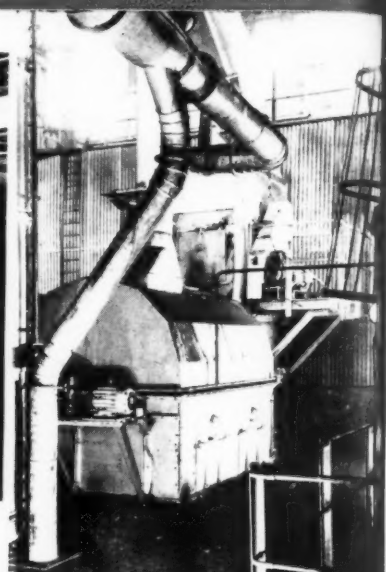

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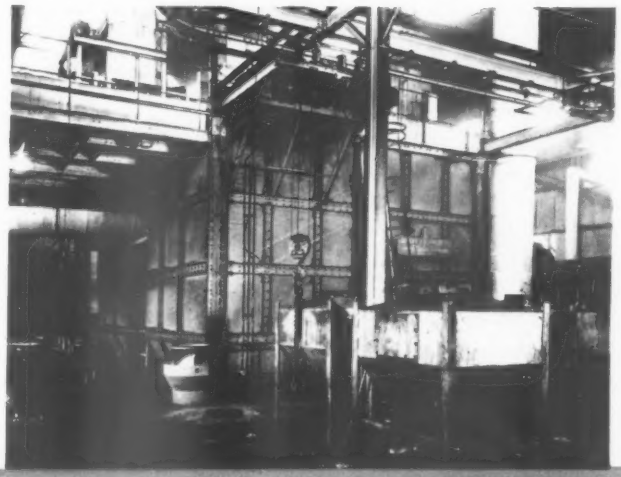

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The Challenge—I

Guest "Leader" from Dr. J. G. Pearce, C.B.E., who retired at the end of 1958 after 25 years as director of the British Cast Iron Research Association, and has since been engaged on various consulting projects in the UK and in Europe.

Much has been written about the challenge offered to the West by the USSR, as a consequence of the wholehearted adoption of modern methods of training and of scientific investigation. Impressive evidence of individual technical achievements has been a Press commonplace in recent months, but apart from some scientific papers read (after translation) by the few specially interested, not a great deal of interest to the foundry industry has emerged. No missions have visited Russia to see progress in this field and consequently no reports have been made. A recent paper by Prof. Y. A. Nekhendzi, who occupies a Chair of Foundry Production at Leningrad, now available in translation, throws a good deal of light on many points. It leaves us in no doubt that the USSR has, or plans to have in the near future, foundry outputs which will make her, in relation to respective populations, comparable in importance with the leading producers in the Western world. It also leaves us in no doubt of the magnitude of the scientific research effort and of the output of trained personnel in this field. It shows that the USSR is fully alive to developments in the West and takes prompt action to follow them up and to improve on them.

The output of castings in pre-revolutionary Russia was annually about half-a-million tons. The paper shows that an output of about 1,000,000 tons of iron and steel castings in 1926 increased to nearly 14,000,000 tons in 1959, with a further increase planned up to 1965, when the annual total will be 20,000,000 tons, of which 16,000,000 will be cast iron and 4,000,000 cast steel. The planned USSR output of 20,000,000 tons by 1965, with a population of the order of 208 millions, will then in all probability exceed the combined UK and USA outputs, where the combined populations will be of the order of 221 millions. This increase in USSR is heartening evidence of the future of the cast metals, but at the same time, it is a formidable demonstration of industrial growth, and it may be well to devote a little further space to the policies on which it is based.

Meanwhile, the writer should add that while the paper shows complete familiarity with Western developments, its many references are solely to Russian sources. Appreciation, however, is accorded to the fact that the American professor, H. M. Howe, in the early years of the present century, dedicated his book "Iron, Steel and Other Alloys," to the famous Russian metallurgist, D. C. Tschernoff. Too much stress should not be laid on this avoidance of other Western references, since the paper is intended to be about USSR and concludes with a general expression of the value of closer contacts and exchange of experience.

MEMORIAL SERVICE

Mr. Barrington Hooper

A memorial service to Mr. Barrington Hooper, chairman of Industrial Newspapers, Limited, was held at the Church of St. Bride, Fleet Street, London, on Tuesday of last week. The full choral service was conducted by the rector, the Rev. Cyril Armitage. Many of Mr. Hooper's friends and acquaintances reflecting his wide sphere of interests in industry, commerce, and social life were present at the service.

Mr. Hooper, who died on September 2, was 75. He founded Industrial Newspapers 34 years ago and was its first managing director. He became chairman of the group in 1955 and was also chairman of the recently formed Industrial Newspapers (Fuel & Metallurgical), Limited, publishers of FOUNDRY TRADE JOURNAL.

An Expert Publicist

The address was given by Mr. F. H. Harley, editor of *Iron and Coal Trades Review* and a director of Industrial Newspapers (Fuel & Metallurgical), who not only has been associated in his professional capacity with Mr. Hooper and the company for more than 30 years, but was also a close friend and colleague, particularly in assisting in organizing the annual conferences of the National Association of Colliery Managers, of which Mr. Hooper held the rare distinction of honorary membership.

Mr. Harley spoke of Mr. Hooper's early career, his undoubted genius as a publicist, his work in that field for the War Loan Tank Campaign and the Victory Loan and Food Economy campaigns of the first world war, which earned for him the honour of CBE, and later—in 1924—his little-realized but nonetheless outstanding success as controller of publicity for the British Exhibition at Wembley, and then the skill and expert knowledge he brought to bear in the sphere of trade and technical journalism.

The characteristics which endeared Mr. Hooper not only to his staff, but his friends and acquaintances were summed up briefly by Mr. Harley in the words: "That in business matters he was shrewd and astute goes without saying. But he climbed up on nobody's back. He was of a kindly and generous nature. He was a good employer; just, sympathetic, tolerant, and understanding. . . . He never stood aloof from his staff; he regarded himself as one of them, and in times of personal need no one ever sought his advice and help in vain."

To this tribute many in the industries of foundry, coal and steel who knew Mr. Hooper have added others, for he was not content to be just a publisher of trade and technical journals, but he went out of his way not only to be well-informed about their progress and problems, but to serve in any way he could the many trades and industries represented by Industrial Newspapers.

In addition to members of Mr. Hooper's family, his fellow directors and the staff of Industrial Newspapers, those present at the memorial service included the following:—

Mr. A. Augstein, Mr. F. H. Ayling, Mr. A. S. Douglas Bate, Sir Paul Booth, Mr. J. W. Butler (also representing Mr. W. P. Newman and Mr. M. J. Glenny), Mr. Jack Crump, Mr. G. R. Curry, Mr. R. E. Dangerfield, Mr. V. C. Faulkner, Mr. J. W. Gardom, Mr. F. E. Godfrey, Mr. L. A. S. Harborne, Sir Guy Harrison, Mr. G. Hewson, Mr. E. F. Laney (also representing Mr. M. F. Higgins and Mr. B. A. Higgins), Mr. F. R. Lewis, Mr. A. J. Long (representing Mr. Richard Miles), Mr. Quentin Lumsden, the Hon. R. G. Lyttelton (also representing the Iron and Steel Institute), Mr. L. R. Mason, Mr. H. Merrick, Sir Frederick and Lady Minter, Mr. D. Cherry Paterson, Mr. Gavin Paterson, Mr. Digby Sperring, Mr. F. Salisbury, Mr. R. B. Templeton, Mr. G. R. Webster (representing the Institute of British Foundrymen), Mr. K. M. Whitworth, Mr. F. Arnold Wilson (also representing Mr. H. J. V. Williams), and Mr. Vernon H. Willey (representing Mr. Allen E. Gilbert).

There were also present many other representatives of the trades and industries and associated organizations covered by the publications in the Industrial Newspapers group.

David Brown Centenary

This year David Brown Industries, Limited, celebrates the establishment of the firm as a master-patternmaking concern at Huddersfield. One of the events of the celebrations was the staging of an exhibition at Mayfaria Rooms, Bryanston Street, London, when the three-stage development of David Brown worm-gear units were demonstrated, and included the latest production, the new Radicon.

A most interesting colour film has also been produced, entitled "A Century of Gearing." It runs for 45 minutes and opens with a reconstructed scene of the original Mr. David Brown's patternshop. Because gear making is largely based on the production of high-grade, sound, castings, this film has much interest for foundrymen. No film has ever connected up so clearly the rôle castings play in engineering products, especially in vehicles involving high speeds. Moreover, the variety of alloys used in the components makes the film of equal interest to both ferrous and non-ferrous founders. The film will be available for showing very shortly and those interested should write to the publicity manager, David Brown Industries, Limited, Park Works, Huddersfield.

An Interesting Presentation

Last Friday, at Guildhall, London, an interesting presentation was made to Mr. Sheriff-Elect, Adam K. Kirk. Subscribed for by his many friends in the Livery, it consisted of a gold chain and badge of office of beautiful design and exquisite workmanship, the badge being decorated with vitreous-enamel work of the highest order. Mr. Kirk is Liveryman of the Worshipful Company of Founders. An Australian by birth, he is a director of Samuel Russell & Company Limited, malleable ironfounders, and is also chairman of Kirk & Company (Tubes), Limited, its parent company. Mrs. Kirk was the recipient of a gold brooch bearing the arms of the City of London.

Mr. STANLEY JESSOP is relinquishing at the end of this month his appointment as sales manager of Fredk. Town & Sons, Limited, Halifax, and Woodhouse & Mitchell, Brighouse, both subsidiaries of Thos. W. Ward, Limited, Albion Works, Sheffield. He is rejoining the parent company on special duties in connection with its engineering activities in Scotland.

Furnace for High-speed Intermittent Melting*

By E. Ayres and W. B. Lawrie, M.B.E., M.Sc., F.R.M.S., A.I.M.

The Paper describes a new approach to the melting and pouring of non-ferrous metals for small castings up to about 50 lb. in weight. The result of the work was to achieve very rapid melting of small quantities of metal. Each charge placed in the furnace was of sufficient weight to fill one mould only and these charges were melted at high speed, intermittently and in quick succession, the time interval between each melt being determined by the speed of casting.

During the last few years, a series of research and development projects have been devoted to the improvement of working conditions in non-ferrous foundries[1, 2]. Two main objects have been to control temperature and fumes and these are frequently inter-related. The present work was concerned both with the design of melting furnaces and with melting practice. So far as furnace design was concerned, the object was to make an efficient unit properly insulated so that the presence of the furnace in operation would virtually make no difference to ambient temperatures in its vicinity. So far as melting practice was concerned, the object was to produce good clean molten metal in order to reduce fluxing and degassing to a minimum in all cases, and to eliminate them wherever possible. This in turn would reduce or eliminate the concomitant fumes. If either or both of these objects could be achieved, it was evident that costs would be reduced as conditions were improved.

This project is the latest in a series done in connection with the technical sub-committee of the Joint Standing Committee on Safety, Health and Welfare Conditions in Non-Ferrous Foundries.

The following matters have already been proved: (1) That in summer, temperatures in die-casting shops may become so high as to impose a severe heat-stress upon men working in them[3, 4]. (2) That some of this heat is waste heat produced by inefficient melting furnaces[3]. (3) That the fuel efficiency of some bale-out furnaces was as low as 13.55 per cent[3]. (4) That a reverberatory furnace could be operated at a fuel efficiency of about 32 per cent[3]. (5) That a reverberatory furnace could be operated at a fuel efficiency of about 44 per cent[6]. (6) That some of the waste heat was radiated from the surface of the molten metal in bale-out furnaces[3]. (7) That furnace insulation was frequently inadequate so that some heat was lost through the furnace walls[3]. (8)That a reverberatory furnace could be operated with much of the external wall surface at temperatures as low as 25 to 50 deg. C[5]. (9) That with suitable refractories very little maintenance is needed and that furnaces melting aluminium will last for long periods of time[5]. (10) That aluminium can be used for pressure-die-castings without degassing and virtually without fluxing[3]. (11) That aluminium can be melted in reverberatory furnaces without undue melting loss[3, 6]. (12) That reverberatory furnaces will give molten aluminium which is for all practical purposes free of gas[6]. (13) That these reverberatory furnaces could be constructed at a low capital cost in suitable circumstances[3]. (14) That these reverberatory furnaces would work at low running costs in suitable circumstances[5]. (15) That melting furnaces can be operated without causing any noticeable increase in the temperature of the melting shop[3, 5, 6] and (16) that the fumes resulting from fluxing and degassing can sometimes be reduced in volume and sometimes eliminated[3, 6].

With these conclusions in mind the Authors of the present paper examined the whole matter again.

Much of the earlier work has been done on aluminium because of its low melting-point and so it was decided that further work might also begin on aluminium, but that it should be extended to the higher melting-point alloys. This has now been done. There has not yet been time to complete careful examinations of the results of melting and casting a wide range of alloys and the furnace has not yet been used on a production basis. Nevertheless, the Authors have agreed to a request that the present results be published so that the industry might be acquainted with a new conception in melting which may offer some advantages to some sections of the trade.

Preliminary Considerations

A further effort was to be made to improve working conditions especially in foundries making relatively small castings (say up to 50 lb.), and the chief objects were to reduce ambient temperatures and to avoid fumes. The foundries in question would probably use dies (gravity or pressure), shell moulds, or perhaps to a lesser extent, green-sand moulds. Melting costs would have to be borne

* This paper is complementary to that entitled "Non-ferrous Reverberatory Furnace" by the same Authors, printed in the JOURNAL, August 18, 1960. Of the Authors, Mr. Ayres is a director of Millspaugh, Limited, and Mr. Lawrie is H.M. Inspector of Factories, Ministry of Labour.

Intermittent Melting Furnace

in mind, and if possible reduced, as conditions were improved. So far as this aspect of the work was concerned, the very suggestion of reducing costs precluded the use of things like screens for radiant heat, or local exhaust ventilation for fumes or for heat, and in fact, lead at once to a discussion of melting practice. The object was not so much to design a new furnace (although finally this was done) as to examine the whole matter of conditions in the light of melting and casting practice.

It was accepted as axiomatic that most of the outside surface of a melting furnace should not exceed 25 to 50 deg. C., and because it was known that this could be done[3, 5] questions of insulating refractories were not discussed. There seems to be no good reason why heat should be allowed to leak away through the walls of melting furnaces to make foundries uncomfortably hot and to waste money and fuel at the same time. If furnaces are fired with gas or oil, direct melting is generally cheaper than indirect. In the past, great stress has been laid on the fact that metals may pick up gas and other impurities if they are melted directly under a flame. What does not seem to have been noticed is that the extent to which impurities are picked up is always a function of time. If metal is melted slowly under a direct flame and then allowed to remain under the flame for hours, quite obviously it will pick up gas. If the furnace conditions are only slightly oxidizing, it will also oxidize the metal. By this time therefore the cost of the fuel to keep the metal molten will have been wasted; the quality of the metal will have deteriorated; further expenses will be incurred in fluxing and degassing in an effort to clean the metal before using it; and the presence of fumes from these latter processes may well involve still more expense in local exhaust ventilating equipment.

Even if metal is held in a crucible some oxidation may occur with the consequent necessity to flux before casting. Unless the top of the crucible has been covered (which is unusual in die-casting shops), the fuel wasted in keeping the metal molten will also have made the shop uncomfortable as heat radiated from the open molten surface. The pouring of large castings obviously requires large quantities of molten metal, so that large quantities must be melted. The pouring of small castings equally obviously requires only small quantities of molten metal, but nevertheless many foundries keep large quantities molten throughout the working day and it is by no means unusual to find hundreds of pounds of molten metal being stored in a foundry which needs no more than a few ounces, or at most a few pounds, every minute. The only possible reason for storing this metal, is that it might be available readily at any time throughout the day. The unpleasantness produced by radiant heat, and by fumes, and the disadvantages arising from metal impurities, seem to be a high price to pay for this.

It appeared therefore that it was wrong to melt and hold large quantities of metal, and that the real necessity was for a rapid melting method which would provide only the amount of metal required—and which would provide it at the moment when it was needed. The whole emphasis therefore, was on speed of melting, both to meet the demands of the foundry for metal, and also to avoid any pick-up of gas and other impurities in the furnace. It would then be no longer necessary for the capacity of the melting furnaces to be in excess of the capacity of the largest mould they fed. This conception would therefore make for smaller furnaces with a correspondingly lower capital cost. They might be cheaper in running costs over the melting period; they would certainly be cheaper in that they would use no fuel for a holding period, and because they were small, they would absorb less heat during any necessary pre-heating period before being brought into use. Much of the heat which has made foundries uncomfortable in the past has radiated from large furnaces and large amounts of molten metal. The proposed smaller furnaces would provide much smaller sources of heat, and so conditions would improve, while the absence of molten metal in the foundry (apart from the small quantities actually being cast) would practically eliminate one source of radiant heat. Rapid melting and immediate pouring would reduce the need for fluxing and degassing. This would mean better conditions, and a financial saving on fluxes, and on the ventilating equipment which is so frequently installed to control the fumes they produce.

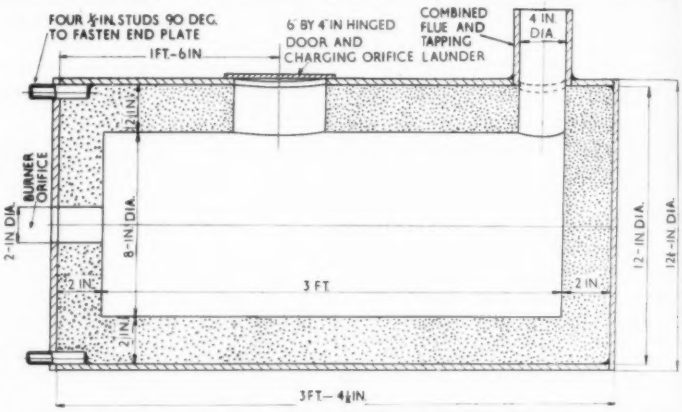

FIG. 1.—*Sectional view of the first experimental furnace developed for rapid melting; it incorporated a rammed refractory lining inside a mild-steel shell.*

Other Considerations

In foundries other than die-casting foundries, the molten metal is normally taken to a mould in ladles or crucibles, from which fumes arise as they are carried about the shop. It is by no means easy to control these fumes. It may be however, that if small quantities of metal could be melted quickly in a small furnace, that the moulds could be brought to a furnace for casting. This would serve to keep the fumes to one point where they could be controlled much more easily.

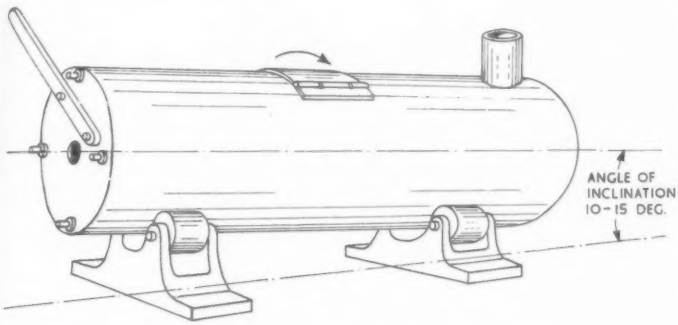

FIG. 2.—*Sketch of the exterior of the experimental furnace, showing the method of mounting on rollers at an inclination of approximately* 15 *deg. from the horizontal.*

One other question arose in discussion on direct melting. Many foundries melt a variety of alloys. The easiest way of ensuring that the analyses of the the alloys are not inadvertently changed during melting, is to keep one furnace, or crucible, for each alloy. There can then be no contamination of an alloy by small quantities of another alloy previously melted in the furnace or crucible. In past practice this has been one of the reasons for using crucibles, and in consequence, one of the arguments in favour of indirect melting. It appeared that a furnace could be kept for each alloy just as well as a crucible, provided only that the furnaces were cheap enough. Capital costs might therefore be of major importance. It may be that suitable refractories would permit alloys to be changed, and this matter is being investigated; but there can be no doubt that it is easier to change the furnace or the crucible.

Every consideration leads the Authors to the one conclusion, that ideally, a melting furnace should melt no more metal than is necessary to fill the die or mould in use. Good metallurgical practice demands that this metal should be melted as quickly as possible, and that it should be poured immediately it has been melted. Molten metal should not be held. So that molten metal would be ready for each new mould as it appears, the time of melting should be less than the time taken to prepare the mould (or die). In the long run this would mean that every pressure-die-casting machine would be fitted with its own small furnace of equal capacity to the die and sprues, automatically fed with the correct amount of metal and integrated into the time-cycle of the machine. This statement could obviously have wider implications in general foundry practice. It is evident enough that even if this were the ultimate end of the work it is certainly not the beginning. The Authors therefore decided to start in the simplest possible way in an effort to determine the time-cycle in which small quantities of non-ferrous alloys could be melted using the most easily available and elementary equipment.

Furnace

The primary consideration was speed of melting and this led to a somewhat unconventional view of the furnace itself, which was now regarded as nothing more than a reservoir of heat. Rapid melting would result if a small amount of metal could be plunged into a large reservoir of heat. The greater the temperature difference between furnace and metal, the steeper the gradient, the better it is for high-speed melting. Little attention was given to fuel because, for the purpose of quick melting, it is irrelevant, and only heat matters. Doubtless, town gas, propane, oil or electricity will all do the work. If gas or oil is used, the flame should be balanced in order to control the atmosphere and prevent oxidation of the metal. If electricity is used presumably the atmosphere in the furnace can be controlled completely. During the preliminary work the size of the furnace seemed to be of little moment, either. For small castings weighing up to a pound or so a very small furnace would suffice to hold the metal, and this might be big enough if it were heated electrically. If oil or gas were used the furnace would have to be large enough to contain the flame, and this would probably be the controlling factor because a furnace that contained the flame would probably hold more than enough metal for many types of mould. The flame might be directed axially or spirally through the furnace. For ease and cheapness of construction the furnaces could probably be rammed, or cast, with suitable refractories.

Experimental Work

Preliminary Trials

The whole conception was so simple that the preliminary trials were done before any special furnace was constructed. In the works where the experiments were conducted the Authors found a refractory-lined tube which was used for other purposes. It was about 4-ft. 6-in. long with an internal diameter of about 4 in. This tube was mounted

Intermittent Melting Furnace

on a bench at an angle of about 30 deg. with its lower end over a bucket half full of sand. An ordinary oxypropane torch was directed down the tube so that the flame filled the interior of the tube as it moved axially along it. Small pieces of aluminium, gunmetal, and aluminium-bronze, were cut and an effort was made to determine the melting time for each piece by means of an ordinary stopwatch.

Five minutes sufficed to raise the inside wall temperature of the tube from room temperature to about 1,500 deg. C. (estimated by a disappearing-filament pyrometer). It was hoped to start the watch as each piece of metal was put into the melting zone and stop it when the molten metal had run out of the tube. However, the aluminium pieces, which weighed 7 oz. each, were melted so quickly that it was impossible to time them with any accuracy. The pieces of gunmetal, also weighing 7 oz., melted in 6½ sec. and the aluminium-bronze pieces, which weighed 12 oz., each took 7½ sec. to melt. On every occasion when the molten metal was caught in a ladle it appeared to be free of gas.

First Experimental Furnace

The results of the preliminary trials were precisely what had been expected and a furnace was constructed as shown in Fig. 1. The dimensions quoted were chosen to contain the flame from an oxypropane torch, and the charging opening was so placed that the metal charge would fall into the hottest part of the furnace. (The dimensions, the position of the charging door, and that of the burner orifice, will always have to be arranged to suit the flame in use if a furnace of this type is flame fired.) The furnace body was constructed of mild-steel plate, the refractory lining being rammed into the body. The construction was simple and cheap.

The furnace was mounted as shown in Fig. 2. The body was inclined at about 15 deg. to the horizontal and could be turned on the rollers about its longitudinal axis by means of the handle bolted on to the burner end of the furnace. In the melting position, shown in the sketch, the short pipe on top of the furnace at the right acted as chimney. As the metal melted it ran down the sloping furnace to the right hand end so that it could be poured into a mould by turning the furnace through 180 deg. on its rollers. The short pipe at the right hand end of the furnace then acted as a launder through which the molten metal flowed from the furnace to the mould. An oxypropane burner was again used as a convenient source of heat and the furnace could be pre-heated in about 15 min., the inside wall-temperature rising from room temperature to about 1,650 deg. C. as shown by a disappearing-filament pyrometer.

Early trials produced molten aluminium which was poured into gravity dies and produced satisfactory castings. Subsequently, other metals were melted, and the cycle from charging the furnace with the cold metal to tapping the molten metal was timed by means of a stop-watch. The following times were easily obtainable:—Gunmetal (85/5/5/5) 4½ lb. in 2 min. 30 sec.; brass (70/30) 7½ lb. in 2 min. 20 sec.; aluminium (L.33) 3½ lb. in 2 min., and aluminium-bronze, 3½ lb. in 2 min. 25 sec. In all cases the metal was free from gas, as would be expected with these melting times. In one case, the aluminium was grossly overheated, but even so, it showed no signs of gas, and solidified with pronounced "sink."

Conclusions

Further work is in hand, but sufficient has been done to indicate certain preliminary conclusions. It should be remembered that the work was put in hand with the aim of improving working conditions in non-ferrous foundries; the primary objective being to reduce ambient temperatures, and also to reduce the volume of fumes during the melting and casting processes involved in the manufacture of small castings, which weighed no more than about 50 lb. A consideration of first principles led the Authors to a somewhat unconventional method, and practical tests have shown that it can be made to work. They agreed to a request that it be published in order to inform the industry of what was considered to be a novel approach to an old problem. There is no doubt that much more detailed information will be needed before the method can be turned from a curiosity into a practical process in daily use, and some of this work is already in progress. In the meantime the following conclusions may both indicate the stage that has now been reached, and serve as a basis for future work.

(1) Metal should be melted as quickly as possible because the amount of gas and other impurities picked up is a function of time.

(2) Metal should be cast as soon as it is melted and has reached the casting temperature. It should not be held in a molten state because this allows it to pick up gas and other impurities.

(3) The only logical corollaries from (1) and (2) are: that the metal should be melted in quantities sufficient only for each mould: that the melting time should be less than the time taken to prepare the die or mould: and that the metal should be charged into the furnace at such time intervals that it can be poured into the die, or mould, as soon as it reaches the proper temperature.

(4) A high-speed intermittent melting furnace has been constructed in an effort to meet the requirements of (1), (2) and (3).

(5) This was a direct melting furnace, and an oxypropane burner was used as a matter of convenience, but any source of heat would presumably suffice. If flame heating is used, the flame should be balanced in such a way as to avoid oxidation of the metal.

(6) The furnace was of simple construction and cheap enough to permit the use of a separate unit for each alloy.

(7) Aluminium, gunmetal, brass, and aluminium-

bronze, have been melted in the furnace. Some approximate times of melting and casting are shown in Table 1.

TABLE 1.—*Melting Times for Various Metals using the Experimental Furnace Developed.*

Metal.	Weight.	Time (sec.).
Aluminium	7 oz.	Practically instantaneously.
.. .. ..	3½ lb.	120
Gunmetal	7 oz.	6½
.. .. ..	4½ lb.	150
Aluminium-bronze ..	12 oz.	7½
.. .. ..	3½ lb.	145
Brass	7½ lb.	140

(8) The molten metal appeared to be free of gas and showed a pronounced "sink" in every case as it solidified.

(9) The furnace can be pre-heated quickly (e.g., 5 to 15 min. from cold).

(10) The method avoids one common source of radiant heat, because there is no continuous pool of molten metal in the foundry. Provision could be made for a water jacket which would result in the elimination of a further source of radiant heat, and which might serve to recover some heat lost in the flues.

(11) The system also avoids the expenditure of fuel needed to keep the pool continuously molten.

(12) Rapid melting and immediate casting reduce the amount of gas and other impurities picked up by the metal and so reduce the amount of fumes from oxidation, fluxing and degassing. This in turn reduces the need for ventilating equipment.

Acknowledgment

The Authors gratefully acknowledge the assistance given by the directors of Millspaugh, Limited, without which the work reported in this Paper could not have been done, and also the technical assistance, materials, and equipment, provided for part of the work by the directors of the British Oxygen Company, Limited. One of the Authors, Mr. W. B. Lawrie, is under obligation to T. W. McCullough, O.B.E., HM Chief Inspector of Factories, for permission to engage in the work, and is also indebted to H. Woods, HM Deputy Chief Inspector of Factories, for his continued encouragement.

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Mr. T. L. GARNER, chairman and managing director of Precision Rubbers, Limited, makers of rubber mouldings and extrusions, of Bagworth (Leics), has been elected president of the European Federation of Purchasing.

End of an Australian Aluminium Partnership

The Consolidated Zinc Corporation, Limited, and the British Aluminium Company, Limited, are to end their joint association in the Commonwealth Aluminium Corporation, Limited, by mutual agreement. British Aluminium, now controlled by Tube Investments, Limited, and Reynolds Metals, has been associated with Consolidated Zinc for the past three years in planning for further development of the aluminium industry in Australia.

The companies said in a joint statement last week that considerable progress had been made towards establishing alumina and aluminium production based on the bauxite resources at Weipa, Northern Queensland, and at Gove, in the Northern Territory. With the consent of the Australian Government the Gove aluminium lease was being transferred from Commonwealth Aluminium (Comalco) to British Aluminium.

The Government has also agreed that British Aluminium would stand in the place of Comalco in negotiations for the purchase of the Government's interests in the New Guinea Resources Prospecting Company, Limited, accompanied by assurances of grants of rights in relation to the Purari River system. British Aluminium was making appropriate financial adjustments with Comalco, and Consolidated Zinc would buy British Aluminium's half interest in Comalco.

Suggestion Schemes Are Not "Welfare Gimmicks"

Britain loses £20.000.000 a year because there are insufficient and inadequate industrial suggestion schemes in operation and for the same reason industrial relations are not as good as they could be. Mr. P. Clavell Blount made this claim at a meeting arranged by the British Productivity Council at Chelmsford.

This country, he maintained, had inventive genius, production know-how, and a manufacturing ability as good as that of any nation, yet its average rate of productivity increase was about 1½ per cent. over the past 60 years, compared with 3 per cent. in the United States.

Mr. Blount criticized the "tradition" still widely held that the production of new ideas was the prerogative of those at the top—people in the lower ranks were not paid to think. For this reason, he said, and because of widespread apathy, complacency, and resistance to change, millions of ideas were stillborn or wasted. Suggestion schemes were no welfare gimmicks. A formal suggestion scheme became essential when an organization grew to a size where immediate and personal contact between the top man and those in the rank and file was no longer practical.

Alcan Industries, Limited

The name of the Northern Aluminium Company, Limited, has been changed to Alcan Industries, Limited. The new name involves no change of ownership, manufacturing activity, or sales policy, its purpose being to identify the company more clearly as a member of the Aluminium, Limited, of Canada group, as "Alcan." It is proposed to retain the trade name "Noral."

Other operating and trading companies in Aluminium, Limited, are currently changing names for the same reasons.

American Letter

Specification for Copper/Nickel Alloys

At the annual meeting of the American Society for Testing Materials held in Atlantic City, New Jersey, during the summer, committee B-5 on copper and copper alloys proposed a new tentative specification for two copper/nickel alloys in ingot, slab, or shot form. The two alloys covered have the following nominal composition—(*a*) Copper 70 per cent., nickel 30 per cent., and (*b*) copper 50 per cent. and nickel 50 per cent. The tentative specification states that the material shall conform to the requirements for chemical composition shown in Table 1, within the limits specified therein.

TABLE 1.—*Chemical Composition requirements (per cent.) of Copper/Nickel Alloys.*

	Alloy A.		Alloy B.	
	Min.	Max.	Min.	Max.
Copper	Balance	Balance	Balance	Balance
Nickel	28.5	31.5	49.0	52.0
Copper plus nickel	99.0	—	98.5	—
Iron	—	0.7	—	1.0
Manganese	—	0.25	—	0.40
Silicon	—	0.01	—	0.01
Carbon	—	0.02	—	0.02
Sulphur	—	0.01	—	0.01
Lead	—	0.01	—	0.01
Tin	—	0.01	—	0.01
Zinc	—	0.01	—	0.01

Specifications for Nodular Iron Castings

Committee A-3 of the American Society for Testing Materials have approved new tentative specifications for austenitic nodular and ferritic nodular iron castings for valves, flanges, pipe-fittings and other piping components. Eight types of material are proposed for austenitic nodular iron castings (see Tables 2 and 3).

The proposed tentative specifications for ferritic nodular-iron castings for valves, flanges, pipe-fittings, and other piping components requires the following chemical composition—Total carbon 3.0 per cent. min.; silicon 2.75 per cent. max., and phosphorus 0.08 per cent. max. Tensile properties—tensile strength 28 tons per sq. in. min.; yield strength 20 tons per sq. in. min., and elongation in 2 in. 15 per cent. min.; Brinell hardness number (3,000 kg. load)—201 max. and 131 min.

Further details of the above may be obtained from the executive secretary, American Society for Testing Materials, 1916, Race Street, Philadelphia, 3, Pa.

Canadian Unemployment

Canadian unemployment moved in opposition to normal movement during the summer and gave rise to fears that depression conditions were beginning to appear. In general, Canada's economy moves with that of the US and an earlier situation of this type in the US seems to have dissolved. US unemployment at about 5.5 per cent. of the labour force is holding firmly against any increase, while the Canadian increase to 4.7 per cent., though alarming, is still within range of adjustments. The news from Canada indicates that Government officials are keenly aware of the need for action.

THE ELEVENTH NORTH-WEST REGIONAL CONFERENCE of the American Foundrymen's Society is to be held from October 21 to 22 at the Hotel Georgia, Vancouver, British Columbia. Amongst subjects to be covered at the technical sessions are the manufacture of pipes; furnaces used in Canada for melting cast iron, and the education of future foundry personnel.

TABLE 2.—*Chemical Composition requirements (per cent.) of Nodular Iron Castings.*

Type.	D-2*	D-2B	D-2C	D-3*	D-3A	D-4	D-5	D-5B
Total carbon, max.	3.00	3.00	2.90	2.60	2.60	2.60	2.40	2.40
Silicon	1.50 to 3.00	1.50 to 3.00	1.00 to 3.00	1.00 to 2.80	1.00 to 2.80	5.00 to 6.00	1.00 to 2.80	1.00 to 2.80
Manganese	0.70 to 1.25	0.70 to 1.25	1.80 to 2.40	1.00 max.†	1.00 max.†	1.00 max.†	1.00 max.†	1.00 max.†
Phosphorus, max.	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Nickel	18.00 to 22.00	18.00 to 22.00	21.00 to 24.00	28.00 to 32.00	28.00 to 32.00	28.00 to 32.00	34.00 to 36.00	34.00 to 36.00
Chromium	1.75 to 2.75	2.75 to 4.00	0.50 max.†	2.50 to 3.50	1.00 to 1.50	4.50 to 5.50	0.10 max.	2.00 to 3.00

* Additions of 0.7 to 1.0 per cent. of molybdenum will increase the mechanical properties above 425 deg. C. † Not intentionally added.

TABLE 3.—*Mechanical Properties.*

Type.	D-2	D-2B	D-2C	D-3	D-3A	D-4	D-5	D-5B
Tensile strength, min., tons per sq. in.	26.0	26.0	26.0	24.5	24.5	27.0	24.5	24.5
Yield strength (0.2 per cent. offset), min., tons per sq. in.	13.5	13.5	12.5	13.5	13.5	—	13.5	13.5
Elongation in 2 in., min., per cent.	8.0	7.0	20.0	6.0	10.0	—	20.0	6.0
Brinell hardness (3,000 kg.)	139 to 202	148 to 211	121 to 171	139 to 202	131 to 193	202 to 273	131 to 185	139 to 193

IMPERIAL ALUMINIUM COMPANY, LIMITED—Mr. W. Brining, Mr. J. M. Graham (directors of Almin, Limited), Mr. J. M. Mitchell, and Mr. S. W. Weyson, deputy treasurer of Imperial Chemical Industries, Limited, have been appointed directors.

LLANELLY STEEL COMPANY (1907), LIMITED—Mr. John L. M. Bevan, who was appointed a director in August, will take up the duties of works director from October 1. He is at present managing director of Baglan Engineering Company (1919), Limited, and a director of other companies in the Duport group.

ALMIN, LIMITED (Associated Light Metal Industries)—Mr. J. M. Mitchell, president of Alcoa International, and Mr. M. J. S. Clapham, joint managing director of the metals division of Imperial Chemical Industries, Limited, have been appointed directors.

VICKERS RESEARCH, LIMITED—The board has been reconstituted as follows:—Mr. A. H. Hird (chairman), Dr. C. F. Bareford (managing director), Mr. W. D. Opher, Mr. W. D. Pugh, Mr. L. Redshaw, Mr. S. P. Woodley, and Mr. R. P. H. Yapp. Mr. A. D. Read is secretary.

American Foundrymen's Congress

Abstracts from papers presented to the recent Congress of the American Foundrymen's Society held in Philadelphia

Austenitic Manganese-steels*

By T. E. Norman, D. V. Doane and A. Solomon

The results of studies leading to the improvement of wear-resistance and mechanical properties of cast austenitic manganese-steels are presented in this paper. In the authors' company's mine and mill at Climax, Colorado, steels having the characteristically high toughness of austenitic 12 per cent. manganese-steels are required in a number of major wearing parts. Some of these are in slusher scrapers in underground operations and in the gyratory and cone-crusher liners in the crushing plant. In other major wearing parts, such as grinding-mill liners, more wear-resistant and less-ductile types of ferrous alloys are used. Part of a continuing investigation into means of improving the wearing qualities, and in some cases the mechanical properties, of high-carbon austenitic steels are covered in this report.

Preliminary studies indicated two promising lines of attack on the problem—(*a*) use of special alloy-additions to 12 per cent. manganese-steel and modifications of the conventional heat-treatment, and, (*b*) an exploration of lower alloy-contents in high-carbon austenitic steels to achieve improved wear-resistance at a somewhat lower ductility or toughness level. The development and study of "lean-alloy" austenitic steels has now been carried to a point where a commercially suitable alloy has been developed for use in parts requiring only moderate ductility or strength, combined with a high degree of abrasion resistance. Such parts include grinding-mill liners, grinding-mill scoop-lips, screen decks and possibly jaw-crusher liners.

Influence of Alloy Additions

Carbon

In general, for wear-resistant castings, it is desirable to hold the carbon content at the highest level possible without seriously injuring the ductility of the steel. For the conventional Hadfield steel, this is usually in a range of 1.10 to 1.25 per cent.

Manganese

A quenched steel containing 1.20 per cent. carbon will be fully austenitic when it contains 5 to 6 per cent. manganese. The development of high ductility and toughness in the austenite generally requires in excess of 10 per cent. manganese. Commercially-produced austenitic manganese-steel castings generally contain 11 to 14 per cent. manganese with a manganese/carbon ratio of about 10 to 1 or higher (Fig. 1).

Chromium, Nickel and Molybdenum

Heavy-section castings made from the higher carbon grades of austenitic manganese-steel are often prone to cracking in the foundry while they cool in their as-cast condition. This is believed to be due largely to embrittlement, resulting from precipitation of carbides around grain boundaries or as plates along crystallographic planes. It is well known that chromium additions tend to aggravate this condition. Molybdenum, on the other hand, when present in amounts over about 1.5 per cent., produces a globular type of carbide which forms in interdendritic sites and minimizes the development of grain-boundary carbides.

The effects of the three most-commonly-used alloying elements—chromium, nickel and molybdenum—on the properties of light-section castings are that molybdenum additions up to about 2 per cent. increase the yield strength without lowering the ductility or tensile strength. Chromium increases the yield strength, although at a slower rate, but lowers the ductility and tensile strength. Nickel does not show a strengthening effect.

Silicon

Silicon is normally added only in the amounts required for good deoxidation. The authors' investigations on both 12 and 6 per cent. manganese austenitic steels with increasing silicon contents up to 2 per cent. confirm that silicon produces a moderate improvement in yield strength.

Phosphorus

Because of its generally harmful effect on the mechanical properties of austenitic manganese-steel, it is necessary to consider phosphorus as one of the important variables in composition. Phosphorus is particularly harmful in heavy-section castings, due to segregation effects. The authors' investigations on manganese/molybdenum austenitic steels, cast in keel-block sections 2-in. thick, indicate that castings containing 0.077 to 0.080 per cent. phosphorus had definitely inferior tensile properties to those having similar compositions and treatments with 0.05 per cent. or less phosphorus.

Special Heat-treatment

Dispersion-hardening

To attain improvements in both wear-resistance and mechanical properties of manganese-steels, a special heat-treatment was devised. This involved first a transformation of part of the austenite to pearlite, followed by a temperature-controlled re-austenitizing treatment which dissolved most of the globular carbides and formed a fine dispersion of spheroidized carbides in the austenite. In a 12 to 14 per cent. manganese composition, it was found that the austenite to pearlite reaction would proceed

* The authors are, respectively, metallurgical engineer with Climax Molybdenum Company, Denver; metallurgical superintendent and research associate with Climax Molybdenum Company, Michigan.

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fairly rapidly during the first hours at 595 deg. C. and would then slow down to an apparent equilibrium condition after about 12 hours, leaving about 35 to 50 per cent. of the austenite untransformed. The controlled re-austenitizing treatment which follows the pearlitizing treatment was carried out at temperatures ranging from 870 to 1,040 deg. C. As would be expected, an austenitizing temperature of 870 deg. C. left greater amounts of spheroidized carbides in the structure than an austenitizing temperature of 1,040 deg. C. The 870 deg. C. austenitizing temperature produced the highest yield-strength and the lowest elongation. With the higher austenitizing temperatures of 925 to 1,040 deg. C., the ductility was greatly improved

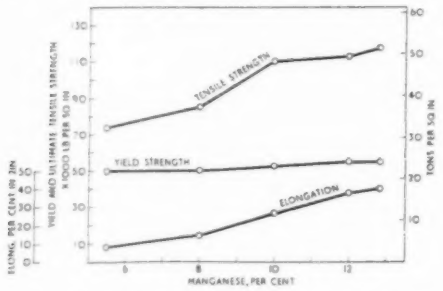

FIG. 1.—*Effect of manganese on the tensile properties of cast austenitic steel, water-quenched from* 983 *to* 1,039 *deg. C. (after "pearlitizing" treatment at* 583 *deg. C.). Basic composition: C* 1.14 *to* 1.20, *Si* 0.61 *to* 0.69 *and P* 0.045 *to* 0.058 *per cent.*

with some lowering in yield strength. For the dispersion-hardened cone-crusher liners and slusher scrapers used in the authors' company, an austenitizing temperature of 980 deg. C. has been used on practically all the castings worn out to date.

Lower Manganese Alloy

Molybdenum and Manganese

Manganese contents of less than 12 to 14 per cent. were investigated for dispersion-hardened 1.2 per cent. carbon compositions, with and without 2 per cent. molybdenum. In heavy-sections, the 2 per cent. molybdenum steels, in addition to having higher yield and tensile strengths, also exhibited better ductility than the plain manganese-steels. In the investigations carried out, it was confirmed that lower manganese contents were accompanied by lower mechanical properties and toughness. In the interests of obtaining improved wear-resistance, the lower-manganese-steels—with their lower toughness—should be usable in many applications. For large cone-crusher liners, however, experience has indicated that a high degree of toughness is necessary to avoid premature failure by breaking or cracking and hence, none of the lower-manganese-steels have yet been tried in cone-crusher liners at the authors' company.

Carbon

Increasing the carbon content is generally one of the most effective means of improving wear-resistance, but carbon levels over about 1.25 per cent. may cause trouble in heat-treatment or foundry handling and may lead also to erratic service-life; consequently, the carbon content is normally limited to 1.20 per cent. The favourable influence of molybdenum in suppressing continuous grain-boundary carbides indicated the possibility of using higher carbon contents without encountering this brittleness. Several liners with carbon contents of 1.4 to 1.5 per cent. were placed in service, and no difficulties were experienced in producing these liners in the foundry.

Silicon

Increasing the silicon content from 0.5 to 1.5 per cent. resulted in a mild increase in yield strength and hardness, with probably some loss in ductility. From observations of both mechanical properties and structure, there appeared to be little advantage (and possibly some disadvantage) from the use of higher-than-normal silicon contents.

Resistance to Wear

High manganese

Hadfield manganese-steel is best suited for applications involving heavy impact and gouging abrasion. Several years of experience had proved that

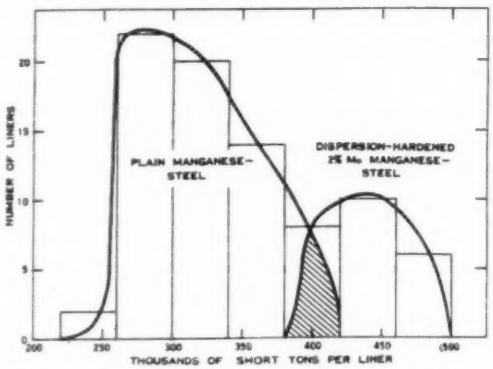

FIG. 2.—*Frequency chart of service "life" of liners for a cone-crusher at the authors' company between* 1955 *to* 1959.

the 12 per cent. manganese/2 per cent. molybdenum modification gave the best performance under given conditions. Solution-treated 12 per cent. manganese/2 per cent. molybdenum steel usually showed some benefits over Hadfield manganese and the 2 per cent. chromium type, particularly where large sections or heavy impact were involved. The most significant improvement is shown in Fig. 2 which gives the life obtained on cone-crusher liners of dispersion-hardened Mn 12/Mo 2 steel. This composition had also been used in a number of

other applications, including hammers for impact pulverizers, stationary jaw-crushers, grizzly-screen sections, and blades on folding-type scrapers. In conditions involving high stress/abrasion (such as in grinding-mill liners) best wear-resistance had been obtained when the carbon in steel compositions was kept in solution, rather than having it present as carbides in the structures. The loss in wear-resistance as a result of the dispersion-hardening treatment amounted to about 5 per cent., when comparisons were made by the wear-test procedure. The wear-test results were of academic interest only, since the relatively high wear-rates on all of the steels made them economically unsuitable for ball-mill-liner service in the mills.

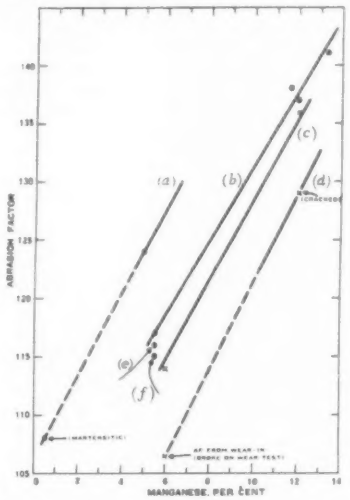

FIG. 3.—*Relative abrasion factors of austenitic steels with varying manganese contents (at authors' company). Key: (a) 1.00 per cent. carbon; (b) 1.20 per cent. carbon; (c) 1.35 per cent. carbon, 0.5 per cent. molybdenum; (d) 1.35 per cent. carbon, 3.0 per cent. chromium, and 0.5 per cent. molybdenum; point (e) 1.20 per cent. carbon, 0.5 per cent. molybdenum, and point (f) 1.20 per cent. carbon and 1.0 per cent. molybdenum.*

Lower Manganese

With the fact well established that lean-alloy, high-carbon austenitic steels were capable of providing good wear-resistance, the next task was to develop compositions of this type which would also have adequate toughness for commercial use in a wide variety of wearing parts. Table 1 lists the compositions, microstructures, hardness, tensile properties and abrasion factors (relative wear-rates) obtained from this series. Each composition was sand cast and heat-treated both as Y-blocks for tensile-test specimens and as 4½-in. dia. balls which were tested in a 9-ft. dia. primary ball-mill at the authors' company. Only items (1), (2) and (8) exhibited satisfactory toughness in the 4½-in. dia. balls tested. Some of the compositions, such as items (3), (7), (15) and (16), probably have insufficient austenite-stabilizing elements to retain a fully-austenitic structure in zones of alloy segregation, such as can exist near the centre of balls. Magnetic tests on the recovered sections from the broken balls indicated the presence of non-austenitic phases near the centre of many of them. Further experiments were carried out to investigate the effect of silicon and copper on these compositions. In general, silicon additions were found to injure wear-resistance and a case of breakage of balls containing silicon occurred; additions of copper to the basic 5½ per cent. manganese-steel were also found to lower wear-resistance but it may be permissible to lower the manganese content when adding copper and in that case manganese/copper combinations might be commercially feasible.

Summary

From the wear tests on marked balls run to date at the authors' company, it has been found possible

TABLE 1.—*Results from Preliminary Series of Lean-alloy Austenitic Steels.*[1]

Item No.	Composition, per cent. C.	Mn.	Cr.	Mo.	Ni.	Cu.	Micro-structure[2]	Hard-ness, BHN.	0.2 per cent. yield, tons per sq. in.	Tensile, tons per sq. in.	Elongation, per cent.	Reduction of area, per cent.	Abrasion factor[3]
1	1.34	12.0	—	0.5	—	—	A	207	26.7	47.2	26.0	31.5	136
2	1.37	6.0	—	0.5	—	—	A	217	25.4	37.4	15.0	23.1	114
3	1.34	3.0	—	0.5	—	—	A	201	Y-block cracked on quenching				broke
4	1.34	12.0	3.0	0.5	—	—	A,C	228	30.5	47.8	18.0	16.0	128
5	1.35	5.9	3.0	0.5	—	—	A,C	228	29.5	39.0	10.0	10.0	broke
6	1.33	3.0	3.1	0.5	—	—	A,C,Dgb	241	29.9	36.8	4.5	5.9	broke
7	1.36	1.5	3.0	0.5	—	—	A,C,Dgb	248	Y-block cracked on quenching				broke
8	1.34	1.5	3.1	0.5	10.0	—	A,C	241	26.2	37.5	9.5	11.3	127
9	1.34	1.5	3.0	0.5	5.1	—	A,C	228	26.7	30.3	4.0	5.0	broke
10	1.34	1.5	3.0	0.5	2.6	—	A,C	207	26.7	32.3	3.0	5.5	broke
11	1.33	1.5	3.0	0.5	—	3.0	A,C,Dgb	228	28.1	32.4	2.5	3.7	broke
12	1.35	2.5	3.0	0.5	—	3.0	A,C	241	26.0	32.4	5.0	11.3	broke
13	1.35	2.4	—	0.5	—	6.3	A,Dgb	223	25.4	31.4	5.0	9.1	broke
14	1.36	1.5	3.0	0.5	—	6.2	A,C,Dgb	255	27.6	33.8	3.5	2.8	broke
15	1.35	1.5	3.0	1.0	—	—	A,C	235	Y-block cracked on quenching				broke
16	1.33	1.5	3.0	2.0	—	—	A,C	241	Y-block cracked on quenching				broke

(1) All groups solution treated by a water quench from 1,092 deg. C. (2) Microstructures observed: A—Austenite; C—Carbide phase, and Dgb—Dark-etching grain boundaries (probably carbide-envelopes). (3) Abrasion factor is rate of wear relative to a factor of 100 for a martensitic steel air-quenched from 1,037 deg. C. containing C 1.0, Mn 0.8, Cr 6.1, and Mo 1.0 per cent.

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to summarize the influence of manganese, carbon, molybdenum and chromium-plus-molybdenum on abrasion factors of solution-treated austenitic steels (Fig. 3). A chromium addition to these steels improved their wear-resistance but tended to embrittle them, so that wear-resistance might be more effectively improved with less loss in toughness by reducing manganese rather than by adding chromium.

6 - 1 Alloy

On the basis of the information recorded in the preceding paragraphs, a specification for the company's 6 - 1 alloy has been adopted for ball-mill liners, ball-mill grates and certain other wearing parts in the mill and crushing plant (Table 2). The characteristics of the 6 - 1 alloy, which include comparatively good abrasion factors, moderately good ductility and ready adaptability to economical commercial production make it appear well-suited for use in most ball- and rod-mill liners, as well as in ball-mill discharge grates. Several sets of ball-mill shell liners, end liners and discharge grates are on test at the authors' company.

TABLE 2.—*Specification of "6-1 Alloy" Castings.*

(1) Melting furnace: basic-lined electric or open-hearth.
(2) Composition (per cent): Carbon, 1.25-1.40; manganese, 5.50-7.00; silicon, 0.40-0.70; molybdenum, 0.80-1.20; and phosphorus, 0.05 max.
(3) Treatment: (*a*) Allow castings to cool slowly to room temperature or at least below 546 deg. C. in their sand moulds; (*b*) heat slowly to 1,037 to 1,092 deg. C.; and (*c*) water quench.

In the discharge grates, wear measurements indicate they will have a "life" of 23 to 26 months as compared with 11 to 12 months in the same service for the 0.5 to 0.6 per cent. carbon, pearlitic chromium/molybdenum cast-steel grates (Brinell 250 to 300) normally used in these mills. In the ball-mill shell liners of "thin shiplap" design, wear measurements indicate that the 6 - 1 alloy steel liners will have a life of approximately 4,200 operating hours, compared with a normal life of 3,000 to 3,300 hours for 0.80 to 0.90 per cent. carbon pearlitic chromium/molybdenum steel (Brinell 350 to 400) and with 3,400 to 3,800 hours for 0.65 to 0.75 per cent. carbon, martensitic chromium/molybdenum steel liners in the same service.

Conclusions

Austenitic steels having a combination of good mechanical properties and improved resistance to gouging abrasion (as in cone-crusher liners) are produced when carbide dispersions are developed in the 12 per cent. manganese high-carbon types of austenitic steel. The carbide dispersions, together with grain refinement, are obtained by combining a 2 per cent. molybdenum addition with a special disperson-hardening heat-treatment.

Service tests in ball-mill liners, grates, scoop lips and in jaw-crusher liners and grizzly-screens indicate that 6 per cent. manganese, 1 per cent. molybdenum, 1.3 per cent. carbon steel, solution-treated, has good abrasion-resistance in both grinding and gouging types of abrasion, this steel being solution treated by water quenching from 1,040 to 1,095 deg. C.

High-silicon Aluminium Alloy*

By E. E. Stonebrook

Pressure-die-castings in an aluminium alloy designated X392 have been developed to provide a combination of characteristics which would best satisfy the requirements of parts subjected to wear, whilst retaining satisfactory castability, and machinability. The nominal composition of alloy X392 is Si 19.0, Cu 0.6, Mg 1.0, Mn 0.4 per cent. and aluminium, balance. Hypereutectic Al/Si alloys have been used only to a limited extent in the USA, but have achieved some success in Europe, particularly in Germany for the production of heavy-duty pistons. Adoption of phosphorus refinement of the primary silicon crystals in the hypereutectic alloys, with the accompanying improvement in machinability and reduction in segregation, as well as the need for greater wear-resistance, have stimulated renewed interest in these alloys.

Phosphorus Refinement

Silicon crystals are the primary phase in these alloys and are normally quite large unless solidification is rapid. These primary silicon crystals tend to segregate in a casting because of differences in specific gravity, and also contribute to poor machining characteristics. These disadvantages as well as inferior castability tended to hold back utilization of the alloys. Introduction of a small amount of phosphorus into a melt will refine the primary silicon, reducing segregation and improving machining characteristics. Several sources of phosphorus have been used for this refinement of primary silicon, including red phosphorus, copper/phosphorus alloys, phosphorus pentachloride and different proprietary materials. Satisfactory refinement generally is obtained with additions of about 0.01 to 0.05 per cent. phosphorus and retention of refinement is reasonably good, generally lasting for a 2-hour or longer holding-period in the molten condition. The general opinion is that phosphorus combines with aluminium to form aluminium-phosphide particles which act as nuclei and initiate the growth of many more silicon crystals than would be formed in the absence of favourable nuclei. Sodium and calcium destroy the refining action of phosphorus and should be virtually excluded from the metal if optimum refinement is to be obtained.

Development of Al/Si Alloys

The use of phosphorus refinement combined with the adoption of carbide tools for machining has served in America as an impetus to the increased application of the hypereutectic Al/Si alloys.

* The author is research metallurgist at Aluminium Company of America, Cleveland.

A series of radioactive tool-wear tests revealed that phosphorus refinement reduced the rate of tool wear to 40 to 70 per cent., and machinability tests indicated that the alloy should contain at least 0.5 per cent. copper. However, substantial copper additions to the X392 composition actually resulted in an increased amount of shrinkage in castings and impaired corrosion resistance. The one per cent. magnesium was adopted to provide improvement of strength and hardness. The addition of manganese contributes to good properties at elevated temperatures; titanium is added for grain refinement in experimental sand and gravity-die-casting, but is not required in pressure-die-casting.

Melting and Casting Procedure

With the X392 alloy, metal pouring temperatures should be somewhat higher than those used for most aluminium casting alloys and suggested ranges are 730 to 740 deg. C. for pressure-die- and from 760 to 815 deg. C. for gravity-die-castings and sand castings.

Although hydrogen porosity is not a problem in alloy X392 pressure-die-castings, thorough degassing should be employed for melts to be used in sand and gravity-die-castings. As is the case with other alloys, fluxing with chlorine gas is most effective, although other degassing treatments may be used.

Casting Characteristics and Properties

Alloy X392 is reported to have excellent fluidity or die-filling capacity and relatively good resistance to "die soldering" and hot-cracking, but the feeding ability of the alloy is relatively poor in sand and gravity-die-castings. In the latter group the alloy is subject to a concentrated or centreline type of shrinkage, associated with solidification of a large quantity of eutectic material, and therefore generous use of feeder-heads and relatively steep temperature-gradients between the first portions of the castings to solidify and the feeder-heads are necessary to ensure sound castings.

Representative mechanical properties of alloy X392 are listed in Table 1. The —T5 or —T7 temper treatment provides substantial removal of growth and improved dimensional stability which may be important for applications involving operation at elevated temperatures. Phosphorus refinement increased the tensile strength by from 1.3 to 2.2 tons per sq. in. for sand castings and about 0.9 tons per sq. in. for gravity-die-castings, but had little effect on elongation and hardness values. Physical properties of the alloy are given in Table 2. A high silicon-content has a desirable effect both in lowering specific gravity and co-efficient of thermal expansion and the latter characteristic is particularly important for parts such as pistons and engine-cylinders where a small clearance is desirable.

TABLE 1.—*Typical Mechanical Properties of Alloy X392*[1].

Casting process.	Temper.	Tensile strength tons per sq. in.	BHN.
Pressure-die (typical) ..	-F[2]	18.3	110
	-T5[3]	18.7	110
Sand (experimental) ..	-F[2]	9.8	75
	-T5[3]	11.6	85
	-T7[4]	14.3	110
Gravity-die (experimental)	-F[2]	12.5	90
	-T5[3]	13.8	100
	-T7[4]	17.4	110

(1) Elongations in all tempers approximately 0.5 per cent. for sand and castings and 0.2 per cent. for pressure die-castings; (2) As cast condition; (3) Artificially aged 8 hr. at 205 deg. C.; (4) Solution heat treated 8–12 hr. at 525 deg. C. quenched in boiling water and artificially aged 8 hr. at 205 deg. C.

TABLE 2.—*Physical Properties of Alloy X392.*

Specific gravity		2.64
Weight per cu. in.		0.095 lb.
Approximate melting range deg. C		550–675
Average coefficient of Thermal Expansion, in per in. per deg. F; Range	56–68 ..	9.7×10^6
	68–212 ..	10.3×10^6
	68–392 ..	10.7×10^6
	68–572 ..	11.2×10^6

Thermal Conductivity at 25 deg. C. (CGS units)	Temper.	Casting process.	
	-F	Sand, die-cast	0.22
	-T5	Sand	0.22
	-T5	Die-cast	0.23
	-T7	Sand	0.25
	-T7	Gravity-die	0.28

Applications

Alloy X392 pressure-die-castings are being used for parts requiring resistance to wear and abrasion, *e.g.*, in a belt-driven automatic transmission for a motor-scooter. Wear by the belts is considerably less than with the (American) alloy 380 (Si 8.5, Cu 3.5, Fe 0.6 per cent., bal. aluminium). Automobile-clutch friction-rings are also being produced and other parts being tested include cylinder-liners, cylinder blocks, pistons, brake-drums, sheaves and pulleys. Aluminium brake-drums are reported to dissipate heat approximately three times faster than cast-iron drums and as a result, brake-lining temperatures and fading are substantially reduced with aluminium. In general, test results have been favourable from the standpoint of wear-resistance and demonstrate the advantage of the lighter weight and higher thermal-conductivity of alloy X392 compared with cast iron.

Precision-casting Mould Materials*

By W. G. Lawrence

Investment material for precision instrument casting must have the following desirable characteristics: (1) Sufficiently high temperature-stability; (2) ability to harden in a controlled period of time; (3) simplicity in preparation; (4) a minimum of dimensional change, and (5) be economical in practice. Mould materials used for the casting of irons, steels, titanium or zirconium need to be considered in this high-temperature category. Refractory aggregates which will withstand the

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temperatures involved include silica, alumina, chrome-oxide, magnesia, zirconia, mullite, forsterite, zircon, calcined clays, spinel, etc. Of materials other than oxides, there are at least 14 nitrides with melting or decomposition temperatures above 1,650 deg. C., and 16 carbides in the same category.

The aggregate is the least troublesome part of any investment mould, most of the troubles coming from the bonding material. The smaller the percentage of bond material and the lower the percentage of liquid required to produce a pouring mix, the lower is the shrinkage during curing, the closer the re-reproducibility of dimensions and the fewer the casting defects. Data on ethyl-silicate/silica investments show that the particle-size distribution of the aggregate which produces the closest packed system requires the least silicate solution and produces the greatest strength.

Thermal conductivity of precision-casting mould materials is of great importance, as the much lower thermal conductivities of the investment-type materials—as compared to sand moulds—results in a lower thermal-gradient within the metal section and less stress. Fig. 4, which illustrates this effect for a sphere of varying diameter for two types of mould materials, also shows the advantageous effect of pouring moulds hot, other than to prevent misruns. The six-fold decrease in the freezing time of the metal, with the resulting lowering of temperature- and stress-gradients within the metal during the "slushy" solidification state, makes possible the production of castings in investment materials not otherwise possible in conventional sand moulds.

High-temperature Binders

The ability of ethyl-silicate to deposit silica from solution makes it useful, not only in the precision investment casting field, but as impregnants or adhesives in other areas. Three types of ethyl-silicate are available, of which condensed ethyl-silicate (28 per cent. SiO_2) and ethyl-silicate "40" (whose name arises from the fact that it contains approximately 40 per cent. SiO_2) are used in the precision-casting field, because of the lower cost per unit of available SiO_2.

Steps necessary in the use of ethyl-silicate for binders vary with each individual manufacturer, thus the procedures described must be taken as general, not specific. Assuming that ethyl-silicate "40" is used as the starting material, one must cause it to react with water in order to produce a solution which will deposit the adhesive form of silica desirable for bonding. To bring this about, the following mixture is recommended: Ethyl-silicate "40" 37.6 (by volume); 190-proof ethyl alcohol, 59.8, and 3 per cent. HCl 2.6 per cent. This is called an "anhydrous" solution, since only enough water has been added *via* the ingredients to complete the hydrolysis process. This mixture should be allowed to stand with occasional agitation for at least two hours before use. Such solutions are stable and may be stored for reasonable periods without deterioration or gelling, provided that excessive evaporation of the alcohol is prevented.

Gelling

Many ways may be used to promote gelling, all depending upon pH control and the addition of excess water. The pH of the anhydrous solution approaches 1-2. As the pH is raised, the gelling time will be decreased; at a pH of 6, the gelling time will be 60 to 90 sec.

For a desired setting time of 50 to 60 min., the following binder and mix is recommended: Aggregate (SiO_2) 99.6 (vol.); MgO 0.4, 100 vol., and anhydrous binder solution (containing 6.5 vol. water), 21.0 per cent. In this instance, the MgO acts as a neutralizing agent for the HCl and because of this action, care must be taken to ensure even distribution of the oxide in the mix, otherwise hard and soft areas will appear in the mould. The percentage of anhydrous solution used varies widely, but for maximum strengths, the maximum amount should be used, with little or no water added.

Setting time is easily controlled by the addition of salts of strong bases and weak acids. NaOH and Na_2CO_3 may be used, but are rather difficult to control. Ammonium salts, such as NH_4OH, $(NH_4)_2CO_3$, are more easily controlled, or the amines may be used. This is the basis on which Patents have been issued on the Shaw Processs. Some of the materials suggested are piperidine, morpholene or triethylamine. The percentages of amines used varies between 0.1 and 1 per cent. by volume, based on the volume of the anhydrous silicate-solution. During the setting process, it is desirable to vibrate the mixture in order to release trapped air-bubbles as well as to pack the aggregate into its most dense arrangement with a minimum of bond thickness between grains.

Since an investment of fine-particle size, with the precipitated bond between grains, has a low permeability, precautions must be taken to ensure proper curing of the mould. For small castings using permament patterns, ignition of the alcohol (mentioned above) immediately after the pattern is stripped is sufficient. For wax patterns, such a procedure is not possible, since the pattern must be removed by heating, the wax burned off and the mould-surface dried or fired.

Phosphate Binders

A number of phosphates have been used for the bonding of refractory aggregates, including aluminium, calcium, magnesium, zinc and lead phosphates. The one of most interest to the precision-casting process is the magnesium-phosphate bond. Due to industrial hazard involved in the use of phosphoric acids, other phosphates may be used such as di-hydrogen ammonium phosphate. Most commercial phosphate-bonded investments have setting times of 15 to 30 min.; boric acid acts as a retarder, *e.g.* 0.25 per cent. will double the setting time. The usual commercial phosphate binders contain approximately 41 per cent. MgO and 59 per cent. $NH_4H_2PO_4$. Such an investment com-

position would approximate: Aggregate 80 parts, bond 20 parts and water 15 to 25. However since these materials are sold compounded ready to mix with water, their use is simple and foolproof.

After setting, the mould is cured by heating and indications are that a mould baked at 600 deg. C. should contain no gaseous products. At 1,375 deg. C. $Mg_2P_2O_7$ decomposes to release P_2O_5 and this accounts for the rough surface which is sometimes experienced on castings when using this type of material for metals with pouring temperatures in the region of 1,375 deg. C.

Cements

Two calcium-aluminate compositions are available, $CaO\text{-}Al_2O$ and $CaO\text{-}2Al_2O_3$, stable at 1,600 and 1,720 deg. C. respectively. Both of these materials are hydraulic setting and may be used as bonding materials for other refractory aggregates. A typical mix using calcum monoaluminate is: Aggregate 60 to 80 parts, cement 20 to 40 parts and water 30 to 50. The setting of calcium-aluminate cements is like cements of the Portland type—it is a reaction with water which produces a gelation and hardening. Evolution of water

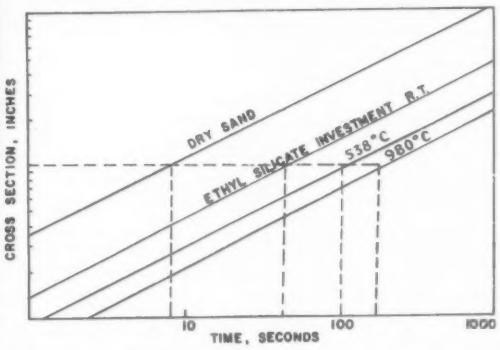

FIG. 4.—*Freezing time of spheres of varying diameter cast into two types of moulding material.*

begins at 490 deg. C. and is complete at 600 deg. C. and from this temperature to 1,000 deg. C., there is no further evidence of any reactions. Cement has one disadvantage in that the water-adding reaction is exothermic, which results in considerable temperature rise. This effect is not serious with small cross-sections, but may become a problem in large masses of investment.

"Glascast" Process

The original "Glascast" process, as developed by the Corning Glass Works, was one involving a cope-and-drag type of mould. This mould was made by drain casting, using plaster-of-Paris moulds such as are used in the slip casting of other types of ceramic bodies. The material used for this process was the high-silica glass powder "Vycor" which has a composition of SiO_2 96, B_2O_3 2.5, and other ingredients 1.5 per cent. Since it is a glass, not a crystal, the coefficient of expansion of this material is low. For making a mould, a slurry prepared of four parts "Glascast" powder to one part of water (by weight), is poured into the plaster-of-Paris mould and allowed to set for a certain time, depending upon the wall thickness desired, and then excess is drained. The greenstrength of the mould is believed to be due to the soluble silica and the "fired" strength is developed as a result of the sintering of the fine glass-particles. Moulds are fired to 1,050 deg. C. for 15 to 20 min. to ensure uniform temperature; drying and firing shrinkages are said to be negligible. Obviously, this method is not adaptable to the precision process which uses a wax pattern and another method has been developed for this situation. For this, a light shell ($\frac{1}{2}$- to $\frac{1}{4}$-in. thick) is built up on the wax pattern by a process of dipping into a slurry and applying a stucco having a glass grain. This system usually involves five to six cycles to build up the wall to the proper thickness. Two slurrys are used, designated A-10 and A-0, and these have the compositions shown in Table 1.

TABLE 1.—*Compositions of Two Typical Slurries.*

—	A-10.	A-0.	American supplier.
"Glascast" powder, gm.	4,540	4,420	—
Ball clay, gm. ..	—	113	—
Aerosol OT 75 per cent, ml.	1.25	4.5	American Cyanimid of N.Y.
Tartaric acid, gm. ..	—	42.5	—
"Methocel" (1.5 per cent sol.), ml.	25	—	Dow Chemical Co., of Mich.
Gum arabic (10 per cent sol.) ml.	—	681	—
"Nalcoag," 35 per cent, ml.	112.5	228	Nalco Chemical Co., of Chicago.
Water, ml.	1,010	432	—

The A-10 slip is a heavy, slow-drying mix used only for the first dip-coat, while the A-0 mix is lighter, faster drying and is used for all additional coats. The aerosol AT is added to promote the wetting properties of the slip; "Methocel" contributes hardness and toughness and bond in the "green" state, and "Nalcoag" (35 per cent.) serves as a binder and adds to the hardness of the coating. Gum arabic provides high greenstrength in the primary coat composition and also acts as a suspension agent. Ball-clay thickens slips, promotes suspension and improves flow properties and its primary function is to raise the yield-point of the slip, in that it is flocculated by the tartaric-acid addition.

A mould is built up by dipping the wax pattern in the A-10 slip, applying a stucco of "Glascast" grain and allowing the whole to dry for about one hour. The mould is then dipped in A-0 slip, stucco is again applied and dried; after five coats the mould is left to dry overnight. The mould thus formed is fired by placing it directly into a furnace at 900 to 1,000 deg. C., the wax burns out and after a period of 15 to 20 min., all residual carbon is burned out and the mould is then ready for casting.

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AFS Congress Papers

Low-temperature Mould Materials

Plaster of Paris

The material of greatest importance in the manufacture of moulds for low-temperature metals is gypsum or plaster-of-Paris. When plaster-of-Paris is mixed with water, the following characteristics are observed: A setting or initial stiffening of the paste occurs about 20 min. after mixing, and shortly after the initial set, a pronounced temperature-rise and measurable expansion occur, which reach a maximum 20 to 30 min. later.

For precision-casting purposes, gypsum is seldom used alone. Other materials are added: (1) to increase thermal conductivity (*e.g.*, SiO_2); (2) to improve strength and cracking tendencies (asbestos, glass-fibres, talc); (3) to improve permeability (inert materials, foaming agents), and (4) to overcome shrinkage of the plaster when heated.

Permeability. The major problem involved in using plaster is permeability and to improve this, the autoclave method and foaming-agent procedure are two main methods used. In the autoclave treatment, the set gypsum moulds/cores are heated in an atmosphere saturated by water-vapour at a temperature of 96 deg. C., the usual pressures recommended being in the range of 10 to 30 lb. per sq. in. After the autoclave treatment, the cores are cooled —preferably in a moist atmosphere—and in this way, cores having a smooth, fine-grained surface with a porous interior are produced.

Another method of imparting the necessary permeability is the foam method. This involves the incorporation of a foaming agent with the plaster, which forms a thin skin on the mould-surface behind which there is a bubble structure, which results in conferring a high permeability to the mould or core without the autoclave treatment.

Since it is impossible to pour metal in contact with such a hydrated mineral due to the release of water and subsequent disastrous result, it is necessary to dehydrate such a core by heating. Providing the permeability of the material is sufficiently high, it is necessary to remove only $1\frac{1}{2}$ molecules of water from the gypsum and certain claims have been made that the remaining $\frac{1}{2}$ molecule of water is advantageous, since it chills the metal at a faster rate. This is no doubt true, provided the gases released may escape through the mould and not the metal The temperature needed for the removal of $1\frac{1}{2}$ molecules of water is 180 deg. C. and for the remaining $\frac{1}{2}$ molecule 215 deg. C. Great care is taken to provide proper venting for plaster moulds. Under ideal conditions, such moulds may be used for all metal temperatures below 1,225 deg. C.

Dimensional Changes

The dimensional stability of a mould is determined largely by the characteristics of the aggregate adopted, with some contribution from the binder—which depends on the percentage of bond and liquid in the original mix. If one considers the number of common additions such as talc, glass fibres, foaming agents or asbestos, which may be used, the thermal-expansion curve would have to be determined for each mix. However, as long as the expansion is constant for a given refractory, the foundryman can provide for it in the original patterns.

UK Steel Output Rise in August

Production of steel in August was still affected by the summer holidays. It reached an average of 422,900 tons a week compared with 391,400 tons a week in July, and with 337,100 tons a week in August, 1959. The production of pig-iron was at an average of 291,400 tons a week compared with 288,900 tons a week in July, and with 219,600 tons a week in August, 1959.

Imports of steel have continued to rise, and in the first seven months they amounted to nearly 1,000,000 tons, valued at £63,000,000—three times as large as in the same period of 1959. Steel sheet, mainly for the motor industry, accounted for about half the imports.

Latest pig-iron and steel output figures (in tons) with the corresponding 1959 returns, are shown in the following table:—

Period.	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
1960—June ..	295,200	15,353,000	464,400	24,255,000
July ..	288,900	15,024,000	391,400	20,355,000
August ..	291,400	15,152,000	422,900	21,988,000
1959—June ..	235,000	12,235,000	388,500	20,200,000
July ..	221,600	11,521,000	320,000	16,654,000
August ..	219,600	11,418,000	337,100	17,527,000

Thyssen seeks Bigger Interest in German Steel Firms

Application has been made by August Thyssen-Hütte, AG, to the high authority of the European Coal and Steel Community to acquire half the share capital of two other West German steel companies, Stahl-Und Walzwerke Rasselstein, and Handelsunion, AG, part of the Otto Wolff concern. Thyssen-Hütte now holds about a quarter of the equity of both companies. Another quarter of Handelsunion equity is owned by Thyssen-Hütte's sister company, Phoenix Rheinrohr, and an equal amount by the Rheinstahl concern. It is understood that Rheinstahl might be ready to sell its share.

In the case of Rasselstein, majority control lies with the Otto Wolff concern, and under the Thyssen proposals this would remain so. The Thyssen and Otto Wolff concerns have a long-term arrangement under which Thyssen-Hütte—which makes mill tinplate—supplies coils to Rasselstein, and Rasselstein products are sold by the Wolff trading organization. Wolff has given Thyssen an option to increase its Rasselstein holdings up to 50 per cent.

The Otto Wolff concern confirmed last week that it had applied to the High Authority of ECSC for permission to take over a further 25 per cent. of the ordinary shares of Stahlwerke Bochum. If the application succeeds, Otto Wolff will acquire a further 25 per cent. of Stahlwerke Bochum's share capital from a banking consortium to get a majority.

Large Castings Defects . . . . .

. . . . Their Significance to Founders and Designers

Relatively rapid changes in design of prime movers to accommodate greatly enhanced performance now places greater stresses on component parts. This calls for careful review of acceptance standards based on past experience. This important question is discussed with regard to the problem of more stringent inspection that it presents to founders, and general design principles indicated that would help them to achieve sound castings. The following abridged extracts, relating to castings, are from a comprehensive paper contributed by F. Buckley, B.Sc. (English Electric Company, Limited), to a recent symposium on "Internal Steel Quality and Methods of its Assessment," arranged by the West of Scotland Iron and Steel Institute.

Designers of plant here envisaged have some knowledge of the inconsistency of steel masses and also of possible weakness caused by cavities and inclusions, allowances being made for these in any overall factor of safety. The establishment of the latter is dependent also on previous experience, but, due to the dynamic nature of design trends, this is of limited application. Thus, for example, in the field of steam-turbine prime movers, whereas 15 years ago sets of a maximum size of 30,000 kw. with steam temperatures of around 430 deg. C. were being produced, there are now single units up to about 500,000 kw., steam temperature up to about 600 deg. C., and pressures in excess of the critical value.

A similar story could be told of practically every other branch of engineering. Not only are larger components being used, but steels of vastly improved character as regards strength and high-temperature characteristics are also being employed. Past experiences, therefore, are only of limited value and have to be applied with great care. In addition to these developments as regards performance, new detection methods have become available which clearly demonstrate the imperfect character of steel products previously regarded as sound, and while there may be some satisfaction in knowing the best or worst of a forging or casting, the responsibility for deciding the suitability for acceptance of a component for critical and arduous duty can be very onerous.

Scope of Study

To illustrate the problems and difficulties confronting the users the author has made a detailed study of castings which are used in prime mover manufacture. These are representative of the highest degree of skill and care of the foundryman, and collaboration between the users and producers has led to rigorous standards of inspection and acceptance. Further, the quality and range of the products are typical of those used in a wide range of engineering fields, ranging from high-speed high-temperature gashed rotors common to steam-turbine practice to the heavy low-speed shafts and other components used in water turbines. The emphasis in every instance is on reliability, as any failure of either a casting or forging, particularly if associated with a rotating part, may involve a high risk to human life and heavy financial loss. An outline is given, therefore, of the acceptance standards applied to these important products and the type of defects that are acceptable. It should be emphasized that although these standards are high and have only been attained after long, and in some instances bitter, experiences by the manufacturing establishments, yet to the credit of all concerned, castings in this field of the requisite standards are being regularly produced at the present time.

Quality of Inspection

Dealing first with the important castings for steam-turbine practices these are mainly the casings which house the rotor and the housing, for the valves which control and govern the steam. The main requirements in every instance are stability and freedom from distortion under long-term high-temperature loading, coupled with ability to prevent cracking due to thermal fatigue effects. These conditions are ensured as far as possible by correct composition, heat-treatment, and, most important of all, careful design of the component. In addition, the castings must be free from any defects which could act as sources of weakness in service.

Acceptance of the castings, therefore, includes careful inspection at the founder's works in which case magnetic crack detection and acid pickling play an important part. The latter is particularly effective in revealing hot tears at changes of section, these being completely removed and rectified by welding. Radiography is mostly confined to selected areas, outlet zones for welded connections and regions of particular importance to the founder, in which case satisfactory radiographs are expected and usually obtained. The word "satisfactory" is used in preference to "clear" as applied to the radiographs as there are standards beyond which it is unnecessary to proceed. Isolated blowholes, for example, the repair of which may involve extensive probing, metal removal and a weld size completely out of proportion to the original defect can usually be quite safely ignored.

Large Castings Defects

Secondary Shrinkage

Extensive radiographic examination of castings of this type, particularly those involving considerable complexity of design, invariably shows a considerable amount of secondary shrinkage, the main feature being capillaries at the centre of the sections involved, which always present a problem as regards acceptance. They can be so fine in nature and so widespread that any question of complete removal becomes almost impossible. Further, being essentially a liquid shrinkage problem they are associated with changes of section where comprehensive radiography is almost impossible and as such a detailed assessment of the full extent is difficult.

The degree of secondary shrinkage permissible, therefore, becomes one of the most difficult problems regarding acceptance, and the following points influence the final decision:—(1) Location in relation to critical area of stress; (2) location in relation to possibility of thermal stress effects; (3) nature of secondary shrinkage, that is, whether truly central, and degree of concentration. It can be stated that no case has ever been observed where secondary shrinkage has given trouble in service.

Influence of Design

Many failures have occurred in service which have been concerned with undetected tears at changes of sections which, under the effect of repeated heating and cooling, have developed into major cracks. The shrinkage on cooling of liquid steel is 1.6 per cent. per 100 deg. C. and on solidification a further contraction of 3.05 per cent. of volume is experienced, which places a formidable burden on the foundryman in securing true progressive solidification. The solution as applied to large highly-stressed castings appears again to rest with the designer, in constructing a relatively simple component which allows the pattern of solidification to be accurately forecast. Further, it is advantageous to break down complicated shapes and cast the parts separately, welding them together subsequently. The cast/weld construction has been brought to a high pitch of perfection particularly in steam chests.

Turbine-runners

No mention of castings is complete without reference to the water-turbine runners which involve heavy dynamic loading, in particular the complicated integral cast Pelton bucket wheels, which are normally required in 12 per cent. chromium steel. Here the most important thing is freedom from cracks at the roots of the bucket, which calls for the most careful attention in these areas. It can be mentioned that one specialist foundry concerned with the manufacture of this type of casting has installed betatron equipment for the investigation of critical areas.

Conclusion

In conclusion, the user must of necessity heartily welcome and embrace any new testing techniques which yield him more detailed information about the internal conditions of castings. Intelligently used and co-ordinated to previous experiences the employment of these additional agencies need not automatically imply increased rejection rates. Indeed, it should be possible to eliminate to a large extent the factor of ignorance which in the past has resulted in many scrapped castings.

In this respect it would be interesting to compare the relative effects of design features that involve stress concentrations against natural occurrences such as non-metallic inclusions and even hairline cracks. On the other hand, steelmakers and steelfounders are constantly demonstrating that the regular attainment of the necessary standards can be accomplished and with the wider application of such additional processes as vacuum casting, the designer and user can look ahead with reasonable confidence to the new important developments that depend so much on the reliability of these products.

Babcock & Wilcox/Vecor Agreement

A long-term purchasing agreement has been concluded between Babcock & Wilcox, Limited, and Vanderbijl Engineering Corporation, Limited, Pretoria (Vecor), under which Vecor will purchase the Vereeniging works at present owned and operated by Babcock & Wilcox of Africa (Pty), Limited, valued at about £1,000,000. Babcock & Wilcox is to acquire 400,000 ordinary shares in Vecor in part payment for these assets. At the same time Vecor will take a 25 per cent. holding in the African company of Babcock & Wilcox.

By these arrangements, the African company of Babcock will benefit from the increased scope of manufacturing facilities, and Vecor will benefit by the immediate availability of further manufacturing capacity. When the agreement becomes effective at the end of 1960, there will be an exchange of directors between Vecor and the African company of Babcock & Wilcox. The agreement is subject to the approval of the UK and South African Treasuries.

Payment of Wages advice

Spread of the banking habit to the wage-earner was welcomed by Mr. H. J. Witheridge, public relations officer, Midland Bank, one of a panel of speakers who discussed payment of wages at a meeting organized by the British Institute of Management in London last week. He warned, however, that if this sort of system was suddenly adopted throughout the whole of industry it would impose a burden upon the banks which, physically, they could not support.

He did not foresee any great change in the general pattern of methods of salary payment for the next 10 years. What the banks would like to see from industry in general was payment of wages at fortnightly intervals rather than weekly, possibly in round amounts to the nearest pound or 10 shillings, and a possible staggering of pay days to relieve the banks' burden.

The meeting was under the chairmanship of Mr. C. W. Griffiths, secretary and treasurer, Joseph Lucas (Industries), Limited.

Correspondence

To the Editor of the FOUNDRY TRADE JOURNAL

NON-FERROUS REVERBERATORY FURNACE

SIR,—We have read with interest the paper by E. Ayres and W. B. Lawrie with the title "Non-ferrous Reverberatory Furnace" published in the August 18 issue of FOUNDRY TRADE JOURNAL, page 195. We are in full agreement with the view of the authors that the design of melting furnaces is often crude and with the principles on which their design is based. However, we feel that for the benefit of the uncritical reader two observations need some qualification.

Our first point concerns fuel efficiency. We are convinced that the improved insulation and the compact design combined with the direct impingement of the flame should lead to high fuel efficiency, but we do not think the experiment described on page 197 is a fair test of this. Obviously a considerable amount of heat is always stored in the brickwork of the furnace and this is very significant if compared with the heat requirements of 200 lb. of aluminium alloy. We cannot conceive of any reliable method of checking the oil consumption when melting such a small quantity of metal. We would therefore recommend considering the figure resulting from this experiment for the time being with some suspicion.

Our second point concerns melting technique. The authors state, on page 195, that in their opinion clean metal is obtained from this furnace without the use of any flux. We do not know which kind of test has been applied to the pressure-die-castings produced from the metal but from all experience available we are inclined to doubt very much whether a furnace with direct flame impingement can be relied upon to supply clean metal without fluxing. We do not know whether the solid metal was left to melt on the inclined hearth and drain into the metal well, or whether it was only pre-heated there and then pushed into the well for melting. In either case we would expect a considerable amount of dross to form and some of this dross to be heated to high temperatures. This tends to produce compact oxide particles having a specific gravity near to that of liquid aluminium and, therefore, can produce hard inclusions which are not removed by skimming but remain suspended in the liquid metal. We would be very reluctant to recommend a furnace of this design for use without fluxing.

We do not doubt the authors will have an opportunity of going into these two points more fully in the course of their further work on the furnace.—

Yours, etc.,

DR. E. SCHEUER,
J. WOOD.

International Alloys, Limited,
Aylesbury, Bucks.
September 16, 1960.

Main/Stott Amalgamation

The resources of two manufacturers of catering equipment, James Stott & Company (Engineers), Limited, Oldham (Lancs), and R. & A. Main, Limited, have now been combined as a result of the former's amalgamation with Glover & Main, Limited. For all catering equipment the two companies will in future trade only under the name of Stotts of Oldham. It is expected that the amalgamation will become effective on November 1.

Mr John Bolton becomes Director of BSFA

Mr. John Bolton, who as briefly reported in last week's JOURNAL, is to take up the appointment of director and secretary of the British Steel Founders' Association on October 1, was before the war Assistant Editor of the FOUNDRY TRADE JOURNAL. From 1939 to 1948 he was acting secretary of the Institute of British Foundrymen, and in 1958 he became secretary of the British Investment Casters' Technical Association. For the last six years he has been secretary of the British Steel Castings Research Association. Mr. Robert Barber, whom Mr. Bolton succeeds, is taking up the appointment of sales director of George Blair & Company, Limited, engineers, of Tow Law (Co. Durham), and Springfield Steel Company, Limited, Glasgow, its subsidiary, from that date.

Subsequent upon Mr. Bolton's resignation, Mr. E. R. Smith who has been in charge of the accounts department of BSCRA since 1952, has been appointed secretary of the Association. Mr. C. M. Stoch who is appointed assistant director of research, has been in charge of the plant engineering and industrial health section since 1953, and for the past two years has also been acting head of the steel-making section. Mr. K. Knaggs, B.SC., deputy head of the latter section has been appointed head of the section, and Miss C. M. G. McBroom, B.A., becomes technical secretary. The appointments take effect from October 1.

Forthcoming Events

(The Editor would be pleased to receive from the secretaries of the various technical associations details of their programmes for the 1960/61 session, for inclusion in this column).

OCTOBER 3

Institute of British Foundrymen

Sheffield branch: Presidential address, 7 p.m., at the Technical College, Pond Street, Sheffield.

OCTOBER 4

Institution of Plant Engineers

Peterborough branch: "Modern Trends in Machine-tools," 7.30 p.m., at the White Lion Hotel, Church Street, Peterborough.

OCTOBER 5

Institution of Production Engineers

Nottingham section: "Investment Casting for the Engineer," by I. L. Gwynn, 7 p.m., at the Reform Club, Victoria Street, Nottingham.

Institution of Plant Engineers

Southern branch: "New Factories Act," by A. Simmons, 7.30 p.m., at the Polygon Hotel, Southampton.
Leicester branch: "Metal Stitching," by N. Tinwell, 7.30 p.m., at the Saracen's Head Hotel, Leicester.

OCTOBER 6

Institute of British Foundrymen

West Riding of Yorkshire branch: "Changes in Foundry Techniques and Changes in Man Power," by F. C. Hayes, 7.30 p.m., at the Bradford Institute of Technology.

OCTOBER 7 to 9

Institute of Personnel Management

National conference on "People and Machines," at the Royal Hall, Harrogate.

OCTOBER 8

Institution of Production Engineers

Coventry graduate section: Works visit to the Metropolitan-Cammel Carriage & Wagon Company, Limited, Saltley, Birmingham.

Institute of British Foundrymen

Newcastle and district branch: Works visit to Ashmore, Benson Pease & Company, Limited, Stockton-on-Tees. (Details from secretary.)
Lancashire branch: Presidential address followed by "Foundry Maintenance," by W. D. Ford, 3 p.m., at the Midland Hotel, Manchester.

Latest Foundry Statistics

Steel Castings: The August issue of the *Monthly Statistics*, published jointly by the Iron and Steel Board and the British Iron and Steel Federation, states that the weekly average production of steel castings was in July estimated at 4,400 tons. In June production was estimated at 5,600 tons and in July, 1959, 3,900 tons (estimated). A definite figure is given for the first six months of this year—5,800 tons per week as against 4,900 tons in 1958. When a census was taken of employment in steel foundries on July 9, the return was 18,200 showing an increase of 210 on the June 4 figure. The industry is now employing about 570 female workers.

Copper-base Castings: The September *Bulletin* of the British Bureau of Non-Ferrous Metal Statistics reports that the output of copper-base castings for the month of July was 6,234 tons. For the first seven months of this year, production was 50,211 tons as compared with 42,365 tons for the similar period of 1959.

Ironfounding: The Council of Ironfoundry Associations states that during the week ending July 30 there were 129,879 employed in iron foundries in the United Kingdom. There was virtually no change in employment figures since the count was taken on July 2, but compared with a year ago there is a gain of 7,190.

Light-alloy Castings: The Ministry of Aviation report in a Press release that the production of aluminium castings during June was 8,647 tons made up of 1,757 tons of sand cast components, 4,599 tons of gravity-die and 2,291 tons of pressure-die-castings. The output of magnesium castings was 190 tons.

Pig-iron Production in China

The output of pig-iron at the Shichingshan Works in China has increased 13-fold during the 11 years of "people's government" and the enterprise has become one of the country's major iron and steel undertakings, it is reported. Situated about 12 miles from Peking, it grew up from a small metallurgical plant with two coking batteries and a few blast-furnaces. After "liberation," the abandoned blast-furnaces and coking batteries were quickly put into operation, and by utilizing the experience of Soviet metallurgists, the output of pig-iron was increased several times over. Extensive construction has taken place during recent years, and converter and rolling departments and a whole series of other facilities have been put into service. This has enabled the combine to be transformed into an undertaking with a complete metallurgical circle.

Work is being continued on the reconstruction and expansion of the plant, and a shop producing electrically-welded tubes has been put into service this year. A big converter department and a powerful rolling mill are now being built at the works, and preparations are under way for the construction of a new blast-furnace.

A COURSE arranged by United Steel Companies, Limited, Sheffield, to enable students from universities to gain a complete view of the steel industry which started on Monday, September 12, is being attended by students from Oxford, Cambridge, Bristol, Durham, Edinburgh, Leeds, Liverpool, Manchester, St. Andrews and Wales.

"600" Now Official Trade Mark of George Cohen Group

Registration of the figures "600" as the trade mark of the George Cohen 600 Group, Limited, London, W.12, has been sanctioned by the Trade Marks Office. It is one of the very few numbers which the Board of Trade has permitted to be registered. Evidence is required that purchasers of goods being marketed would associate the figures with the trading activities of the concern seeking to register the mark, and this evidence was supplied by some hundreds of firms in the case of George Cohen.

The "600" mark derives from the transfer in 1876 of the headquarters of George Cohen Sons & Company, Limited, to 600, Commercial Road, London, E.14. Over the years the habit of talking of "going to 600" spread through many concerns in the metallurgical and engineering industries, and in the early 1920s the figures were first used as a mark on goods and publicity. "There are, mercifully, not 600 companies in the group. Today there are 35," said Mr. N. G. P. Boswood, company secretary.

Hepworth & Grandage Expansion

Plans for large-scale capital development announced by Hepworth & Grandage, Limited, Bradford (Yorks), include the purchase of a 22-acre site at Southwick, Sunderland. The first phase of factory construction, is scheduled to commence early in 1961 and by the end of the year it is expected that the new plant will be far enough advanced to commence production with a labour force of 350. Most of the employees will be in the semi-skilled categories and will be sought from the immediate locality of the works. Subsequent stages of construction will develop the whole 22 acres. The new plant will ease the pressure on the company's production capacity at the main Bradford works, which is itself in the process of being extended and modernized as far as the Distribution of Industries Act permits.

Morgan Crucible Reorganization

As part of the reorganization of the Morgan Crucible group, the crucible department will become on April 1, 1961, a wholly-owned subsidiary of the Morgan Crucible Company, Limited. It will be called Morganite Crucible, Limited, and will operate from Norton, near Worcester, where there is already a modern Suprex factory. Transfer of the sales department and some of the technical staff has commenced, and as from October 5 inquiries concerning these departments should be addressed to the parent company at Norton Works, Worcester. Mr. D. Scott who is now in charge of the sales department at Norton becomes sales director of the new subsidiary on April 1. The demonstration and test foundry will remain at Battersea where visitors will always be welcome.

D. NAPIER & SON, LIMITED—Mr. H. E. C. de Chassiron has been elected to the board and is to succeed Mr. H. Sammons as managing director on January 1, 1961. Mr. de Chassiron joined the parent company, English Electric Company, Limited, in 1958 and is at present assistant to the general manager of the Rugby works. Mr. Sammons joined D. Napier & Son in 1942.

Equipment and Supplies

Shell Coreblower

Industrial Foundry Materials, Limited, Lye, Stourbridge, announce that two new shell coreblowers have been added to their range, namely, the "Steloy" SA/1 and DA/1 units. The first is a single machine, designed to produce cores on a completely-automatic cycle without an operator. Alternatively, by the simple throw of a switch the machine will stop at the end of each cycle with the corebox open. When working automatically, the machine (with one double-impression corebox) will, it is claimed, produce hollow cores at the rate of 240 per hr., the cores being ejected by pins located in the box. On auto/manual control, a safety device is incorporated so that an operator cannot get his fingers caught during the initial closing of the box. This is ensured by the necessity to press simultaneously two buttons located on the front of the unit, these being situated far enough apart to require the use of both the operator's hands. Following the depression of these buttons, the already-hot corebox is closed by a pneumatic cylinder.

Sequence of Operation

When the box is closed, the cycle then becomes automatic and the operator can release the two buttons and occupy himself some other way for the period of approximately 25 to 30 sec., or until the corebox is ready to be closed for the making of another core. Once the box is shut, a secondary air-cylinder drives the corebox along two rails to a position over the blowing head. Here, the rails and box tilt slightly, thus dropping the box into accurate location on the blowing head. (The idea of tilting on to the "head" is to alleviate any tendency to wear at the joints as a result of "scuffing.") As the box locates on the head it is clamped vertically, and the blower unit then performs its duty of blowing the core, investing in the sand/resin mixture and exhausting. When the blower unit has completed its operation, the vertical clamp flies off, the guide rails tilt the box off its seating and the secondary cylinder withdraws the box from over the blowing head. At this point, a short curing time is allowed before the primary air-cylinder opens the box and ejects the cores. When the machine is switched to fully-automatic operation all these sequences take place on their own, and as an automatic hopper-feed device can be supplied as an auxiliary, the machine will then run indefinitely, making and ejecting cores. The coreboxes can be heated either by cast-in elements or by electric heater-pads bolted to the back of the box. All the various sequences are individually timed and can be altered easily for different types of core.

Production Rates Available

The blowing unit is so designed that a single-sided model SA/1 machine can be converted into a double-sided model DA/1 machine in a few minutes, but whereas the SA/1 unit described uses one box only, the DA/1 unit employs two with the consequent increase in production. When the JOURNAL'S representative watched these machines running, one SA/1 machine was producing cores off a double-impression corebox, with a simple loose-piece in each core. The loose pieces were withdrawn and replaced automatically in the manner of die-casting dies. The cores came off automatically at a steady 240 per hr. On a second machine, running on auto-manual operation, an operator had to locate two steel inserts into a double-impression box and was producing approximately 200 cores per hr.

As, Sb, Te and Bi: Johnson, Matthey & Company, Limited, Hatton Garden, London E.C.1, announce that they are now producing very pure arsenic, antimony, tellurium and bismuth on a commercial scale. By means of newly-developed techniques, arsenic is being produced with an impurity level of the order of one part per million. The element is in the form of crystalline lumps and is packed in vacuum-sealed glass tubes. Antimony, with a maximum metallic impurity content of five parts per million, and bismuth, with a maximum level of metallic impurities of ten parts per million, are being produced in ingot form. Zone-refined tellurium, with a metallic impurity content of one part per million, is also available in bulk, in ingot or grain.

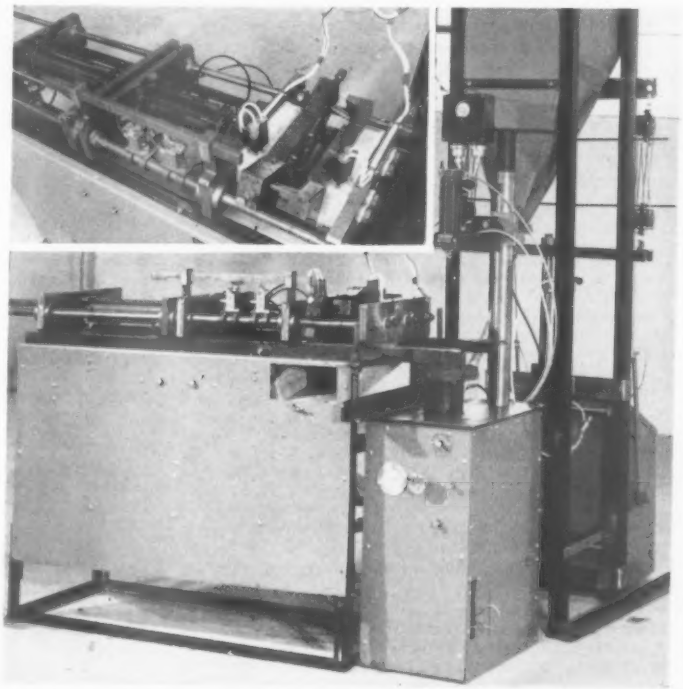

FIG. 1.—*General view of the SA/1 shell coreblower introduced by Industrial Foundry Materials, Limited, of Stourbridge, with (inset) a close-up overhead view of the corebox moving and closing mechanisms.*

Personal

Mr. JAMES MITCHELL has been elected a director of the Patent Shaft Steel Works Company, Limited, steel manufacturers, Wednesbury.

Mr. GLYN MITCHELL has been appointed works director of F. Pratt & Company, Limited, machine-tool-equipment makers, of Halifax.

Mr. F. B. DIXON, who was appointed to the board of Standard-Triumph International, Limited, last April, has been appointed deputy managing director.

Mr. A. W. INGLIS, B.SC.(ENG.) has been elected to the board of directors of Paterson Hughes Engineering Company, Limited, Bedford Street, Strand, London, W.C.2.

Ten days in Stockholm is the prize won by Mrs. CYNTHIA LEWIS, secretary to the Cardiff branch manager of Atlas Copco (Great Britain), Limited, compressed air engineers, in a contest run by her employers.

Mr. H. J. WENHAM, chairman and managing director, and Mr. W. H. CORNETT, price controller, of the Forgrove Machinery Company, Limited, Leeds, have been presented with gold watches on completing 40 years' service with the company.

Mr. W. F. DINES, who joined the board recently, has been appointed general works manager of the Midland Tar Distillers, Limited. He succeeds Mr. W. E. AYLWIN, director, who is retiring from that position tomorrow (Friday), but remains on the board.

For his paper—"The Cascade System"—describing a universal method of deriving pneumatic, hydraulic, and electrical circuits, Mr. A. M. SALEK, sales manager of Martonair, Limited, Richmond (Surrey), has won the fourth prize of $100 in the annual international fluid power contest sponsored by the US publication, Applied Hydraulics and Pneumatics.

Mr. ALFRED RATCLIFFE has been appointed a director of the Metals Division, Imperial Chemical Industries, Limited, and a joint managing delegate director of Marston Excelsior, Limited, a subsidiary company of ICI, with effect from October 1. He will also join the board of another subsidiary, Lightning Fasteners, Limited. Mr. W. ROBSON is retiring as a joint managing delegate director of Marston Excelsior on September 30.

Mr. A. H. HIRD, a director of English Steel Corporation, Limited, Sheffield, and of other companies, has been appointed chairman of the newly-constituted board of directors of Vickers Research, Limited. Mr. W. D. PUGH, managing director of English Steel Corporation and English Steel Forge and Engineering Corporation has been appointed to the Vickers Research board. He is a director of other ESC associated corporations and other companies in the industry.

Mr. L. GRAHAM FIRTH has been elected deputy chairman of Brightside Engineering Holdings, Limited. Mr. R. IVOR SLATER, Mr. P. WRIGHT and Mr. W. CUSWORTH have been elected to the board. Mr. Wright has been appointed managing director of the Brightside Foundry & Engineering Company, Limited, and Mr. Cusworth has been appointed managing director of Buckley & Taylor, Limited, subsidiaries of Brightside Engineering. These appointments take effect from October 1.

Miss MARY BERRY, principal of the business training college associated with Newton, Chambers & Company, Limited, Thorncliffe, near Sheffield, has retired. Retirement gifts from managers at Thorncliffe and past and present students of the college were presented by Mr. P. J. C. BOVILL, Master Cutler and managing director of Newton, Chambers. Miss Berry, who is the first woman national chairman of the National Association for Education and Commerce, is succeeded at the college by Mrs. I. A. B. FLINT, of Doncaster.

Mr. J. J. CASEY, who has almost completed 38 years' service with the Ford Motor Company, Limited, is to retire at the end of this month. He vacates the position of head of the production engineering department in the hot-metal group of Ford's at Dagenham. Prior to his joining the Ford organization in Cork in 1922, he was apprenticed at H.M. Dockyard Haulbowline in Southern Ireland, and later served there as a draughtsman. In 1931, he transferred to Ford's Trafford Park works, Manchester, to supervise and supplement plans for the company's Dagenham foundry, which actually came into production in 1932. When Ford's took over their Leamington premises in 1940, Mr. Casey was responsible for their re-equipment to form a modern mechanized foundry. During the war, his services were used to help conversion of various firms to tank-track production—for example, foundries at Birmingham and Ketley. After the war, he paid a number of visits to the United States also to a number of European foundries to get ideas for Ford's new foundry at the Dagenham works which was destined to become the Thames Foundry, commencing production late in 1957. Mr. Casey intends to return to Ireland for his retirement.

Associated British Engineering Trading Improvement

Trading improvement is reported by Associated British Engineering, Limited, diesel engine manufacturers, of London, W.C.1. There was a consolidated trading surplus of £229,130 for the year ended March 31, 1960, compared with a deficit of £11,406. As for the previous year, no dividend is recommended on the £1,100,000 ordinary capital. Group net profits total £54,779 after tax of £52,188. A net loss of £98,823 was incurred in the previous year, after a tax credit of £100,702.

Profits for 1959-60 exclude those of Henry Meadows, Limited, the equity in which was sold before the end of the financial year. Further development expense was incurred by the free piston engine company, which has again been written off out of general reserve and the major contract for construction of the world's largest free piston power station at Singapore is now in an advanced stage of completion.

Subsidiaries in the marketing of earth-moving equipment have experienced a fall in business, due mainly to reduction in open-cast coal mining. New products and new markets are being actively developed.

British Oxygen Group Trading Changes

Marketing arrangements of the British Oxygen Company, Limited, group are to be reorganized. At the close of business on September 30, the British Oxygen Company is to take over the trading business and assets of six wholly-owned subsidiaries, and it will resume trading in its own name from October 1.

The six subsidiaries are: British Oxygen Gases, Limited, British Oxygen Engineering, Limited, Quasi-Arc Company, Limited, Sparklets, Limited, A. Charles King, Limited, and British Oxygen Research & Development, Limited.

News in Brief

NORMAL WORKING was resumed in the foundry of the Doncaster factory of the International Harvester Company, Limited, on Tuesday of last week, after men had walked out during the night shift.

NORTHERN IRELAND'S MINISTER OF COMMERCE, Lord Glentoran, is on a visit to New York, for the purpose of speaking to industrialists in the United States about Ulster's advantages as a manufacturing base.

PRECISION COMPONENTS (BARNET), LIMITED, Kabi Works, Cranborne Road, Potters Bar, Middlesex, announce that the name of the company has been changed to Kabi (Electrical and Plastics), Limited.

BRIGHTSIDE HEATING AND ENGINEERING COMPANY, LIMITED, have been awarded the work of installation of the heating and hot-water system in the second part of the Sheffield Park Hill flats scheme, at a cost of £11,321.

SHEFFIELD DISTRICT INDUSTRIAL GROUP of the Royal Society for the Prevention of Accidents arranged a one-day conference at the Norfolk Barracks in Edmund Road, Sheffield, on September 27 to mark the annual safety week in industry.

SIMON ENGINEERING, LIMITED, of Cheadle Heath, Stockport, have announced that Simon-Carves, Limited, have secured a £250,000 contract for the supply of a sulphuric-acid plant for installation at San Lorenzo in the Argentine.

B. ELLIOTT (MACHINERY), LIMITED, last week held a Northern Machine Tool Exhibition at the City Hall, Deansgate, Manchester, the second to be organized by the company this year. Demonstrations were given of 77 types of Elliott machine-tools.

IN THE FACE OF COMPETITION from German and other Continental manufacturers, the Leyland Motors group has gained a £400,000 contract from the Municipality of Teheran for re-equipping the city's street-cleansing and refuse-collection system.

DISPLAYS of Redfyre domestic-heating appliances—manufactured by Newton, Chambers & Company, Limited, of Sheffield—will be shown actually "underfire" at the annual Clean Air Exhibition to be held this year in Harrogate from October 4 to 7.

A £200,000 ORDER from a Canadian shipyard has been received by Butters Brothers & Company, Limited, crane manufacturers, Glasgow. The contract, which was obtained against strong competition from American and Continental firms, is for cranes of 75-ton capacity.

FOLLOWING the conclusion of an agreement entered into earlier this year between the International Harvester Company of Great Britain, Limited, and SA de Construcciones Agricolas of Sevilla, an initial 1,000 sets of IH tractor components are shortly being shipped to Spain.

SKEFCO BALL BEARING COMPANY, LIMITED, of Luton, are to build a factory at Irvine, Ayrshire. A subsidiary company is to be set up for the manufacture of production tools, equipment, and specialized machine-tools used in the manufacture of ball- and roller-bearings.

TWO COMMONWEALTH SCHOLARS who are taking up awards in Sheffield under the new Commonwealth and Fellowship Plan, are Mr. R. S. Sandhy, from India, who will study civil engineering at Sheffield University, and Mr. D. J. Corderoy, of Australia, who will study metallurgy there.

THE NEW National Lending Library for Science and Technology at Boston Spa (Yorks) will be one of the largest library sites in the world, Dr. D. J. Urquhart, senior principal scientific officer of the Department of Scientific and Industrial Research, told the Library Association at its recent conference at Scarborough.

EXTENSIONS COSTING £600,000 and providing places for an additional 1,000 students, are shortly to be opened at Rotherham Technical College. There are four new blocks, which include departments of mechanical production and civil engineering. Mining, building, technology and physics, are also catered for.

SEVERAL NEW ITEMS of combustion testing equipment and oil-burner accessories from Shandon Scientific Company, Limited, will be on show on stands 75-80 (Yorkshire Heating Supplies, Limited) at the Northern Heating, Ventilating, Insulation and Refrigeration Exhibition to be held in Harrogate from October 22 to 29.

RHODESIAN ALLOYS (PVT) LIMITED is reported by Barclays Bank D.C.O. to be starting immediately on a £1,250,000 expansion scheme at their ferro-alloys plant in Gwelo. Work will probably take about two years to complete and it is anticipated that completion will coincide with a reduction in the cost of electricity supplies.

WICKMAN, LIMITED, announce that under an agreement recently concluded with Ateliers des Charmilles, S.A., Geneva, they have assumed the sole selling agency in the United Kingdom for the Eleroda Model D.1. electro-erosion machine, a high-precision spark machining unit particularly designed for tool-room applications.

ORDERS TO THE VALUE OF over £1,250,000 have been received during the last three months by the National Gas & Oil Engine Company, Limited. The most recent is for fourteen 1,000 b.h.p. diesel engines covering a power range from 285 to 1,550 b.h.p., received through the company's Canadian associate, Orenda Industrial, Limited.

NEW Mylamaque Explorations Company, Limited, has completed arrangements with Koppers, Limited, Canada, and Strategic Materials Corporation for the construction of a Canadian smelter to produce pig-iron by Strategic's direct production process. The smelter site is near Kingston, Ontario, and production is expected to begin in the middle of 1962.

WEST TINSLEY GOODS DEPOT, Sheffield, will be closed from Monday, October 3, it has been announced by British Railways Eastern Region. A collection and delivery service for freight sundries will continue to be available from the main Sheffield stations, and freight traffic in full wagon-loads will be dealt with at Attercliffe and Broughton Lane stations.

APPRENTICE aged 15, Kenneth George Moorhouse, employed with Alldays & Onions, Limited, foundry and general engineers, of Birmingham, was killed three days after joining the firm when a pin in the hook of a crane sheared and catapulted the pulley and cable at his head. A verdict of Death by Misadventure was returned at the inquest.

THE SOCIETY OF CHEMICAL INDUSTRY announces that Professor A. R. Ubbelohde, M.A., D.SC., F.R.S. (Professor of Thermodynamics, Imperial College of Science and Technology, London), will deliver the Fifth Charles Tennant Memorial Lecture entitled "Melting and Freezing" in the Royal College of Science and Technology (Room 24), George Street, Glasgow on Friday, November 4, at 6 p.m.

News in Brief

A COURSE for buyers in industrial and public undertakings has been arranged by the Purchasing Officers Association to take place at Jury's Hotel, Dublin, on October 28. The conference fee is one guinea for Association members and students and £1 11s. 6d. for non-members. Further details may be obtained from the secretary of the Association, Wardrobe Court, 146a, Queen Victoria Street, London, E.C.4.

A FURTHER ORDER for oil-pipeline valves, placed with the David Brown Foundries Division, Penistone, South Yorkshire, by A.C.F. (Great Britain), Limited, has recently been completed. The valves, designed to withstand a working pressure of 1,400 lb. per sq. in. and each weighing 6½ tons, are being shipped to Latakia (Syria) where they will be installed by the Iraq Petroleum Company in 24-in. dia. pipelines.

PENSION and life assurance schemes for all adult male workers of Arthur Balfour & Company, Limited, tools and tool-steel makers, of Sheffield, and associated companies, are to begin on October 1. They will be for men between the ages of 21 and 64 who have worked at least one year with the group. The scheme will be "substantially better than that proposed by the State," says Lord Riverdale, chairman.

SHEFFIELD'S UNEMPLOYMENT FIGURE of 1,546 on September 12 was 140 fewer than the previous month, and the lowest figure since February, 1957. The number of unfilled vacancies of 2,118 is the highest since September, 1956, and compares with 2,109 in August of this year, and with 1,550 in last January. In the month ended September 7, 1,194 unemployed in Sheffield found work—290 more than in the previous month.

SULZER BROTHERS of Winterthur, Switzerland, have ordered from Quasi-Arc, Limited, Bilston, Staffordshire, a complete automatic welding installation for the fabrication of "pen-stock" pipes, used for water conveyance in hydro-electric schemes. The pipes vary between 16-in. and 8-ft. dia. A special feature of the equipment is the use of a closed circuit television system for observation of the welding process when welding internally on small diameter pipes.

FOR ADMINISTRATIVE REASONS, Jarrow Metal Industries, Limited, a subsidiary of Armstrong Whitworth (Metal Industries), Limited, will cease to exist under that name as from September 30. Its steel foundry at Western Road Works, Jarrow, Co. Durham, will, however, continue to operate under the name of the parent company and production and personnel are unaffected. During its 23 years of existence Jarrow Metal Industries has produced steel castings for industries all over the world.

"INVEST IN THE FUTURE" was the theme of a three-day conference organized by the Federation of British Industries, which opened at Buxton on September 26. It was devoted to the problems of recruiting and training high-quality staff for firms with about 1,000 employees. Sir Norman Kipping, director general of the FBI, was the opening speaker, and Mr. A. G. Grant, chairman of the FBI's education committee, chaired the discussions. Subjects considered included policy and practice in recruitment, training, selection of the next generation of key staff, and creating opportunities for advancement.

AN EXHIBITION of modern industrial metals, designed to interest those concerned with engineering problems involving the use of metals, is being presented by the Mond Nickel Company, Limited, at the South Wales Institute of Engineers, Park Place, Cardiff, from November 1 to 4. The main emphasis of the exhibition will be upon the properties of nickel-containing materials and the platinum metals. Each day at 11 a.m. and 3 p.m. lectures will be given by members of the company's development and research department, and films will be shown at other times during the day. A programme may be obtained from the company, at 20, Albert Embankment, London, S.W.1.

Obituary

Mr. N. J. BOOTH, head of the Chemistry and Metallurgy department, at Chesterfield College of Technology, has died at the age of 58.

The former proprietor of the Haugh Shaw Brass Foundry, Halifax, Mr. ALBERT TOZER, has died at the age of 82. He retired from business in 1942.

Mr. HAROLD LEESON, chief clerk and buyer of Stokes Castings, Limited, engineers, Mansfield, Nottinghamshire, died on September 17. He was 66 years old and had been with the firm for 51 years.

Mr. RICHARD SHARP, former general manager of blast furnaces of the Stanton Ironworks Company, Limited, near Nottingham, died in hospital aged 74. He joined Stanton Ironworks in 1926, and retired seven years ago.

Mr. F. STARKEY, who died on September 14 at the age of 75, was formerly works manager of the Stockton Heath Forge (Caldwells), Limited. He joined the company on leaving school and had completed 55 years' service when he retired.

The death occurred on September 20 at the age of 74 of Mr. THOMAS SOUTHWORTH KITSON, formerly for over 30 years in business as an ironfounder in Mill Lane, Brighouse, and later for 16 years manager for C. H. Broughton, Limited, also of Brighouse.

The death is announced of Mr. GEORGE ARCHER, C.M.G., who was appointed president of the Mond Nickel Company, Limited, in July of this year. He joined the board of the company in 1948, became sales director in 1952 and managing director in 1955. He had been chairman of the company and its subsidiary, Henry Wiggin & Company, Limited, since 1959. Previous to his joining the Mond Nickel Company he had served with the British Raw Materials Mission in Washington, of which he became head in 1945. He was also UK secretary of the Combined Raw Materials Board. It was in recognition of these services that he was awarded the C.M.G. in 1945.

Hardypick/Laycock Engineering Offer

Further to our report on page 416 of the offer by Laycock Engineering, Limited, for the shares of Hardypick, Limited, a late announcement states that the independent party mentioned has notified the board that in view of the official statement issued by Robert Benson Lonsdale & Company, Limited, that Laycock Engineering's offer for the Hardypick capital has been declared unconditional, it is not prepared to carry its enquiries any further.

The Hardypick directors announce that further negotiations are being conducted with Laycock and pending the result of these talks shareholders are strongly advised to take no action whatsoever, particularly since they have been authorized by Laycock to state that in the event of the talks being inconclusive the present offer will remain open for further acceptances.

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Publications Received

Fifteenth Annual Report, 1959/60, of the British Welding Research Association, Abington Hall, Abington, Cambridge.

Inasmuch as it shows the scale of research in an industry kindred to and sometimes competitive with founding, the annual report of the British Welding Research Association (recently issued) has considerable interest for a fair number of JOURNAL readers. Of special interest to the reviewer were the sections on artificially-induced residual stresses, heat-affected-zone studies (especially when considered in relation to the welding of steel castings), the conference on brittle fracture in mild steel, the symposium on fatigue of welded structures, and results of experimental work on the controlled use of local heating and/or mechanical conditioning as a means of increasing strength of components. The Report is also noteworthy because it discloses a substantial volume of fundamental research which is sponsored in co-operation with universities—a line which foundry research establishments may be wise to follow to a greater degree themselves, especially as the reviewer understands the Department of Scientific and Industrial Research will, on occasions, make direct grants from public funds for such work, *i.e.*, apart from the pound-for-pound arrangement under which most DSIR-sponsored research establishments operate.

It is indeed interesting to note that in only fifteen years of operation, the Association's annual income has been stepped up in this last year from £157,000 to something approximating £250,000. During the year, about 50 welding research projects were enumerated in a list of "priorities" circulated to members. In turn, the members themselves submitted suggestions for a further 100 projects and the Association rightly points out that adoption of any of these will require still more money.

Training Boys in Industry—the Non-Apprentice: A booklet published by the Industrial Training Council, 36, Smith Square, Westminister, London, S.W.1: price 1s. 9d. post free.

Early in this booklet it is stated that "the increasingly rapid pace of change in industrial techniques and processes will call for a much higher degree of adaptability upon the part of industry's workpeople than hitherto." This statement applies with special force to the foundry industry, where there are cases such as the sand-mill attendant being absent through some reason or other and being replaced by a machine moulder or a labourer on the melting plant. With the growth of the unskilled or semi-skilled staff in the foundry industry, it would seem to be worthwhile to organize within each sizeable undertaking a scheme for training youths on a systematic basis so as to make them intelligently aware of the processes undertaken and the part they can and do play in the production of saleable goods, and moreover, do this more understandingly. The booklet outlines sixteen examples of firms ranging from Selfridges, Limited, to the English Electric Company, Limited, which have established training schemes for the non-apprentice.

Export made Easy. Published by the Rural Industries Bureau, 35, Camp Road, Wimbledon Common, London, S.W.19, price 5s. 11d. post free.

The Rural Industries Bureau have done good service to the small manufacturer by the issue of this booklet carrying the title "Export made Easy." It reviews the case of a small manufacturer of resin-bonded shoe-trees who thought he would like to export. His friend—a veritable "fairy godfather"—first managed to arrange for a write-up in a trade magazine and as a result an enquiry was received from South Africa. Thereafter, a step-by-step account is given of the paper-work to be undertaken for the development of export business. Sample letters are inserted in the text to clarify the description, whilst the quoted references to sources of information are most useful. It might be thought by readers that here was a case of arguing from the particular to the general, which would detract from the value of the article, but this is not so. Even the sending of samples is dealt with: the use of the (cheaper) certificate of postage is recommended as an alternative to a registered letter; the acquiring of the essential exporting documents and consignment notes are all clearly covered, as are the sending of goods to countries outside the sterling area and credit facilities. There must be many owners of small foundries who are placed similarly to this hypothetical maker of shoe-trees and who could benefit from a study of this 44-page booklet. If their works are located rurally, then the district officers of the Bureau are at hand to help.

* * *

A BROCHURE received from the Management Consultants Association, 4, London Wall Buildings, London, E.C.2, details the type of business its members undertake, lists their eight member-firms and prints their code of professional conduct.

House Organs

Nickel Bulletin, July, 1960. Issued by the Mond Nickel Company, Limited, Thames House, Millbank, London, S.W.1.

In this issue, in the section on nickel and its compounds, reference is made to literature on the reactions involved in porcelain enamelling and on the use of nickel in cathodes. Items pertaining to electrodeposition (which reflect, *inter alia*, the considerable amount of work which is being carried out to improve the corrosion-resistance conferred by nickel/chromium coatings) are followed by sections on non-ferrous alloys (*e.g.*, arc welding of aluminium-bronze using nickel-containing filler metal), and the properties and applications of nickel-iron magnetic alloys.

Advanced Materials Technology, Vol. 3, No. 2. Issued by the Carborundum Company, Niagara Falls, New York, USA.

This publication covers refractory materials used only for exceptional orders or in the research laboratory. Such materials include forms of silicon carbide, diamond ground to great dimensional accuracy, and a wide range of "chemical" refractories. An illustration is given of a pump for molten aluminium made entirely from "Refrax" shapes, including the nuts and bolts.

Magcan Tabloid, September, 1960. Published by the Magnesium Company of Canada, Limited, P.O. Box 6090, Montreal, Canada.

This magazine is issued for the purpose of publicizing the use of magnesium for ordinary engineering and domestic applications. This issue deals with applications for the Volkswagen car, suitcases, extension ladders, housings for calculating machines and portable-typewriter cases.

Compressed Air Comments No. 3, 1960, available from Atlas Copco (Great Britain), Limited, Maylands Avenue, Hemel Hempstead, Herts.

There is just one article about foundries in this issue and this tells something of compressors installed in South African foundries, and the extensive use made of compressed air in the operations for making cast products.

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Raw Material Markets

Iron and Steel

Production of pig-iron keeps pace with demand and all consumers are well provided with supplies. Biggest outputs consist of basic pig-iron which the steelworks continue to absorb fully, and producers are able to dispose of their makes without difficulty. In the foundry grades of iron, the low phosphorus brands are being taken up in substantial quantities by engineering and speciality foundries for the production of high quality castings. From the several sources of supply which are now available, outputs are more than sufficient to meet present needs, and the pressure for deliveries which has prevailed for some time is now showing signs of a steady easing off.

Hematite is also in good supply and substantial tonnages are being taken up. Refined irons are available to requirement. High phosphorus pig-iron is plentiful and makers have tonnages to spare from both production and stocks. Consignments of this iron continue to be shipped abroad to fulfil orders which are being obtained against keen competition from oversea producers. Outputs of high-duty castings at the engineering foundries are maintained at high levels, with the motor vehicle trade still the main consumer, although there is a slackening in demand from some sections of this trade, for which production schedules have been cut.

Demand for castings from many other industries is maintained at a good level. The building trades continue to specify freely for castings and the light foundries catering for them are obtaining good outputs. Foundries supplying castings to the domestic utensil trade are only moderately employed, while the textile and most of the jobbing foundries are reasonably well occupied. Supplies of scrap, apart from special grades, are adequate and deliveries of foundry and furnace coke, ganister, limestone, and firebricks can be obtained to requirement.

The re-rollers continue to be well occupied with full order-books for all their products. Demand is sustained for small bars, light sections and reinforcing rods, and present commitments will keep them fully occupied for some months ahead. The shortage of labour continues to restrict production. In ordinary mild steels most of the re-rollers have plentiful supplies of semis, but the shortage continues for higher carbons and special qualities.

Non-ferrous Metals

Copper in London is holding more or less steady pending the outcome of the Chuquicamata Union's strike vote at the end of this week. At the same time, persistent offerings of the metal to the market are being absorbed somewhat reluctantly and the price has been dropping gently downwards. Meanwhile, copper stocks in LME warehouses are rising and at the end of last week totalled 9,133 tons, an increase of 340 tons in the week.

In the US the position is unchanged. Demand is slow, stocks are building up, and the quotation for both producers and custom smelters is still 33 cents a pound although the metal is changing hands at below this price.

Tin has been a fluctuating market in London, Singapore, and New York, where the price is fractionally above $1.02 cents a pound. Demand in London is still directed towards cash metal and the backwardation is around £3 a ton. At the end of last week, tin stocks in London totalled 9,263 tons their distribution being London, 4,270 tons; Liverpool, 3,543 tons, and Hull, 1,450 tons.

Lead is dull on both sides of the Atlantic. In this country mainly because of the news of further cutbacks in motor car production, and in America because of the uncertain business outlook, weakness on Wall Street and low production in the steel automobile industries. However, the New York spot price is unchanged at 12 cents a pound.

Zinc continues dull and although the substantial bulk of the selling orders are being taken up, prices continue to slide and are now not far above £85 a ton. In the US the market is slow for both Prime Western and special high grades, but the East St. Louis spot price is unchanged at 13 cents a pound.

Capital Expenditure Rises by 18 per cent.

Fixed capital expenditure by manufacturing industry is provisionally estimated by the Board of Trade to have been 18 per cent. higher in the second quarter of this year than in the same period last year.

Expenditure on building in manufacturing rose by £18,000,000 (39 per cent.) and on plant and machinery by £13,600,000 (10 per cent.), compared with the second quarter of 1959.

The wholesale price index of basic materials used in manufacturing industry has been provisionally estimated for August at 97.5 (1954 = 100). The average price level of these materials fell by 2 per cent. over the past two months.

New Factory for Simplex Dairy Equipment

New £100,000 factory of the Simplex Dairy Equipment Company, Limited, Sawston (Cambs), has been officially opened by Lady Gamage, wife of Sir Leslie Gamage, chairman of the General Electric Company, Limited. The company, which is a member of the GEC group, is now under one roof for the first time. Before the move it had three offices, three works, and six stores, all in different parts of Cambridge.

The company makes a wide range of dairy and agricultural products and fabricates tubular steel for agricultural purposes. It plans to expand into industrial tubular metal equipment.

FACTORS AFFECTING BEHAVIOUR AT WORK will be the subject of a talk to be given by Mr. S. Gifford, personnel management advisor, Ministry of Labour, to a London-area meeting of the Association of Bronze & Brass Founders to be held on October 4, at the Clarendon Restaurant, Hammersmith. (The meeting will be preceded by luncheon at 12.30 for 1 p.m.)

AS A RESULT of internal reorganization Joseph Townsend, Limited, an associated company in Scotland of Borax Consolidated, Limited, will cease to trade on September 30, 1960. On that date a branch office of Borax Consolidated, Limited, will be established at 176, Bath Street, Glasgow, C.2, with Mrs. H. McLaren as manager. Local stocks will continue to be held in Scotland, and customers will probably find it convenient to address orders to the new Glasgow branch office rather than London head office.

Baker Perkins Foundry Machinery at work ... *at the Southend Engineering Co. Ltd.*

This Baker Perkins Girojet Universal Shot Blasting Machine operates without compressed air, needs negligible maintenance and costs little to run. And here's another advantage—no foundations are needed. The Girojet will take an evenly distributed load of 500 lbs. Average shotblasting times: aluminium (2-4 minutes); grey iron (3-6 minutes); malleable cast iron or bronze (4.5-8 minutes); forged steel or stamped steel (10-20 minutes).

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HISTORICAL NOTE

Southend Engineering Company was established in 1901, and manufactured Marine and Stationary engines until 1914. The Firm has produced its own non-ferrous castings since 1938. They manufacture the "Viking 3" Outboard Motor, a set of flame guns for agricultural purposes, and a range of Stern Gear and fittings for marine engine manufacturers.

BP/F10

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

September 28, 1960

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2, 10-ton lots or over: Middlesbrough, £21 6s. 0d.; Birmingham, £20 18s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.40 per cent. P, 10-ton lots or over, £23 5s. 0d., delivered Birmingham, £23 10s. 0d., delivered Grangemouth.

Cylinder and Refined Irons.—North Zone, £25 6s. 6d.; South Zone, £25 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.; North Zone, £26 6d. 6d.; South Zone, £26 9s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent., 10-ton lots or over; N.-E. of England (local iron), £23 19s. 0d.; Scotland (Scotch iron), Zone S.1, £24 5s. 6d.; Sheffield, £25 7s. 6d.; Birmingham, £25 14s. 0d.; Wales (Welsh iron), £23 19s. 0d.

Basic Pig-iron.—£20 3s. 0d., delivered Staffs, Derbyshire, Notts, Lincs, Rutland, Northants, and Leicestershire in 10-ton lots or over.

FERRO-ALLOYS

(per ton unless otherwise stated, delivered)

Ferro-Silicon (6-ton lots and over).—45 per cent. Si, £43 10s. 0d. to £46 0s. 0d., scale 15s. 0d. per unit, lumpy; 75 per cent. Si, £59 0s. 0d. to £63 10s. 0d., scale 15s. 0d. per unit, lumpy.

Ferro-vanadium.—50/60 per cent., 20s. 6d. per lb. of V.

Ferro-molybdenum.—65/70 per cent., carbon-free, 12s. 10d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., 2-3 per cent. Cu, £250 0s. 0d.; 38/40 per cent., commercially carbon-free, £287 0s. 0d.

Ferro-tungsten.—80/85 per cent., 12s. 1d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 15s. 1d. per lb. of W.

Ferro-chrome (6-ton lots and over, lumpy).—4/6 per cent. C, £81 10s. 0d. to £84 10s. 0d., basis 60 per cent. Cr. scale 27s. 0d. to 28s. 6d. per unit; over 6 per cent. C, £79 0s. 0d. to £82 10s. 0d., basis 60 per cent. Cr, scale, 27s. 0d. to 28s. 6d. per unit; 2 per cent. C,* 1s. 8d. to 1s. 11d. per lb. Cr; 1 per cent. C,* 1s. 8d. to 1s. 11½d. per lb. Cr; 0.15 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr; 0.10 per cent. C,* 1s. 9¾d. to 2s. 0¾d. per lb. Cr; 0.06 per cent. C,* 1s. 11d. to 2s. 1d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 10d. per lb.

Metallic Manganese.—94/96 per cent., carbon-free, £275 0s. 0d.; 96/98 per cent., £285 0s. 0d.

Ferro-columbium.—65/67 per cent., Cb + Ta, 19s. 9d. per lb., Cb + Ta.

Ferro-manganese (Standard).—78 per cent., £61 10s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft u.t., 100 tons & over, £31 15s. 6d.; tested, 0.08 to 0.33 per cent. C, 6 to 35 tons, £33 15s. 6d.; hard (0.41 to 0.60 per cent. C), under 10 tons, £34 17s. 0d.; silico-manganese, under 10 tons, £43 16s. 6d.; free-cutting, under 10 tons, £36 14s. 6d. SIEMENS MARTIN ACID (under 10 tons): Up to 0.25 per cent. C, £41 1s. 0d.; silico-manganese, £44 4s. 0d.

Billets, Blooms, and Slabs for Forging and for Stamping (under 10 tons).—BASIC: soft, up to 0.33 per cent. C, £38 10s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C £39 12s. 6d.; acid, up to 0.25 per cent. C, £43 4s. 0d.

FINISHED STEEL

Heavy Plates and Sections (1 ton to 10 tons).—Ship plate (N.-E. Coast), £41 12s. 0d.; boiler plates (N.-E. Coast), £44 2s. 0d.; floor plates (N.-E. Coast), £43 10s. 0d.; angles (N.-E. Coast), £38 16s. 6d.; joists (N.-E. Coast), £38 12s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., and flats 5 in. wide and under, untested soft basic, 50 tons and over, £39 1s. 0d.; under 10 tons to 4 tons, £40 18s. 0d.; under 4 tons to 2 tons, £41 3s. 0d.; hoop and strip, coils, 100 tons and over, £38 0s. 0d.; uncoated strip mill coils, hot rolled, under 3 mm. to 12g., 25 tons to under 50 tons, £43 16s. 0d.; black sheets (hand mill), 24g., 10 tons and over, £57 14s. 6d.; galvanized corrugated sheets, 24g., 10 tons and over, £68 5s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £67 17s. 0d.; nickel-chrome, £98 11s. 0d.; nickel-chrome-molybdenum, £111 4s. 0d., in lots of 5 tons to under 10 tons.

NON-FERROUS METALS

Copper.—Cash, £231 15s. 0d. to £232 0s. 0d.; three months, £233 0s. 0d. to £233 5s. 0d.; settlement, £232 0s. 0d.

Copper, Tubes, etc.—Solid-drawn tubes, 2s. 3⅝d. per lb.; rods, 251s. 0d. per cwt. basis; 20 s.w.g., 286s. 0d. per cwt.

Tin.—Cash, £806 0s. 0d. to £806 10s. 0d.; three months, £803 0s. 0d. to £803 10s. 0d.; settlement, £806 10s. 0d.

Lead (Refined Pig).—Second half September, £68 10s. 0d. to £68 15s. 0d.; second half December, £69 5s. 0d. to £69 10s. 0d.

Zinc.—Second half September, £87 15s. 0d. to £88 0s. 0d.; second half December, £86 0s. 0d. to £86 2s. 6d.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £123 0s. 0d.; rolled zinc (boiler plates), all English destinations, £120 15s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £102 10s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 1s. 10⅞d. per lb.; sheets to 10 w.g., 206s. 0d. per cwt.; wire, 2s. 8⅝d.; rolled metal, 206s. 0d. per cwt.

Brass (Brazing).—BS1400, B3, £170; B6, £223.

Brass (High Tensile).—BS1400, HTB1, £195; HTB2, £212; HTB3, £228.

Gunmetal.—BS1400, LG2, £214; LG3, £224; G1, 1% £284; G1, 1%, £274.

Phosphor Bronze.—BS1400, PB1 (AID released), £309; BS1400, 90/10/1, £297.

Leaded Phosphor Bronze.—BS1400, LPB1, £236.

Phosphor Bronze Strip, etc.—Strip, 293s. 3d. per cwt.; wire, 4s. 1⅜d. per lb.; rods, 3s. 4½d.; tubes, 3s. 4½d.; chill cast bars, solids 3s. 4½d.; cored 3s. 5½d (CHARLES CLIFFORD, LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 11½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 4½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 3½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 2½d. to 2s. 3d. per lb.; Antimony, English, 99 per cent., £200 0s. 0d. Quicksilver, ex-warehouse, £69 0s. 0d. Nickel, £600 0s. 0d. Aluminium, ingots, £186 0s. 0d.; aluminium bronze (BS1400), AB1, £249, AB2, £258.

* Average 68-70 per cent.

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Company News

Hardypick Receive New Offer

Broadcasting plans for future developments " is not necessarily nor in fact always in the best interests of the shareholders and the less said in this direction the better," states Mr. Thomas G. Jameson, chairman of Hardypick, Limited, makers of mining tools, coal- and rock-drilling machinery, etc., of Sheffield, in his annual review.

He reports brisk current trading and better prices for many specialities and hopes for a " still more favourable " balance-sheet at the end of the current year.

As has been reported, the directors have advised rejection of a bid of 30s. for the £1 preference and 65s. for the £1 ordinary from Laycock Engineering, Limited. The net profit of Hardypick of £17,210 (£10,012) for the year to June 30, 1960, is in line with the figures given in the board's circular advising rejection of the bid. The final dividend, as then indicated, is to be 17½ per cent. making 25 (20) per cent.

The directors of Hardypick announced last week that a new approach has been made to the company's advisers by an independent party, who has deposited an amount in excess of that offered on behalf of Laycock Engineering in a bank in the name of such party's solicitors. Holders are advised to take no action for the time being. They will be notified of further developments as soon as possible.

GLOUCESTER RAILWAY CARRIAGE & WAGON COMPANY, LIMITED—Following a reduction in the interim payment from 6d. to 4d. per 10s. share, the company is reducing the final by 4d. to 8d. per share for the year ended May 31, 1960.

HENRY BALFOUR & COMPANY, LIMITED—It is intended to raise £250,000 in cash shortly by means of a rights issue. Application has been made to the council of the London Stock Exchange for a quotation for the issued ordinary capital of the company.

UNIVERSAL ASBESTOS MANUFACTURING COMPANY, LIMITED—Only £173 of the original £260,000 6½ per cent. convertible loan stock is now outstanding. Of the £20,350 outstanding on August 31, holders of £20,177 have now converted into 72,637 5s. ordinary shares.

MARTIN BROS. (MACHINERY), LIMITED, machine-tool manufacturers, of Manchester—Net loss of £2,170 was incurred in the year ended June 30, 1960, compared with a previous profit of £918 after tax of £574 (£860). The dividend is reduced from 14$\frac{7}{12}$ per cent. to 8½ per cent., but this time holders are to receive 4d. per 2s. share, not subject to tax, out of surplus arising on realization of fixed assets.

WELLINGTON TUBE HOLDINGS, LIMITED—Group net profit expanded from £501,073 to £696,408 in the year to June 30, 1960, and the dividend is raised from the approximate equivalent of 14.3 per cent. to 17½ per cent. with a final of 12½ per cent. Trading profits and other income increased from £1,028,965 to £1,414,082, subject to tax of £717,674 (£527,892). As known, the company has made an offer for the capital of Gibbons (Dudley), Limited.

SOLAR INDUSTRIES, LIMITED, Glasgow (formerly Aluminium Castings, Limited)—Final dividend of 12½ per cent. exceeds the forecast by 2½ per cent. and makes 17½ per cent. for the year ended March 31, 1960, on £800,000 capital. This is against a previous total of 15 per cent. on £400,000 prior to a one-for-two scrip issue and a cash placing, or a 10 per cent. equivalent taking the scrip issue into consideration. Net group profit was £214,674 (£121,169) after tax of £237,116 (£166,000).

BROWN BAYLEY, LIMITED—The parent and its two operating companies, Brown Bayley Steels, Limited, and the Hoffmann Manufacturing Company, Limited, are raising the interim dividends for 1960. Brown Bayley's interim is raised to 5 (2½) per cent. Brown Bayley Steels to 5 (3) per cent., and Hoffman, on the capital doubled by a scrip issue, to 7½ (3¾ equivalent) per cent. It is aimed to bring the interim and final dividends more into proportion and it cannot be assumed that the total will be increased.

ASSOCIATED ELECTRICAL INDUSTRIES, LIMITED—Group net trading profit for the half year to June 30, 1960, dropped slightly to £4,940,000, before tax, compared with the corresponding period last year and with £6,090,000 for the second half of last year. Orders received, mainly for delivery within three years, amounted to £113,000,000, against £84,900,000 and £97,100,000. A second interim dividend of 6d. per £1 unit is declared making 1s. per unit to date, as before. A total of 3s. per unit was paid for the previous period.

British Oxygen to make Rights Offer

The directors of the British Oxygen Company, Limited, have decided to raise some £12,270,000 by way of a rights offer. Ordinary shareholders are to be offered one 5s. ordinary share at 18s. for every five held on September 15. The issue will not be underwritten. Shareholders are informed that expected capital expenditure of £28,000,000 announced by Mr. J. S. Hutchison last March has now increased to around £40,000,000. The extra money is needed for production capacity to supply industrial gases in large quantities to the steel industry and other users and for general development.

Provisional allotment letters are expected to be posted on October 21. A first instalment of 10s. per share will be payable on acceptance on November 16 and the final instalment of 8s. on January 25. The new shares will not rank for the final dividend for the year to the end of this month.

Group trading profit for the year is estimated at £9,400,000, against £8,587,144 in 1959. The directors expect to recommend an unchanged final dividend of 10 per cent., making a total of 16 per cent. for the year and to maintain that rate on the increased ordinary.

Vickers shows Half-year Sales and Profits Rise

Vickers, Limited, increased its group sales to £75,670,000 in the six months to June 30, 1960, compared with £73,030,000 in the corresponding 1959 period, and the net profit rose from £1,780,000 to £2,490,000. The full year's figures for 1959 were £155,540,000 and £4,930,000, respectively. So far as the second half of the year is concerned, the directors state, business remains active and it is estimated that profits are running at about the same level as in the first half.

Orders on hand at June 30 last totalled £286,000,000 compared with £295,000,000 at June 30, 1959, and £282,000,000 at December 31, 1959. The interim dividend is maintained at 2½ per cent. A total of 10 per cent. was paid for 1959.

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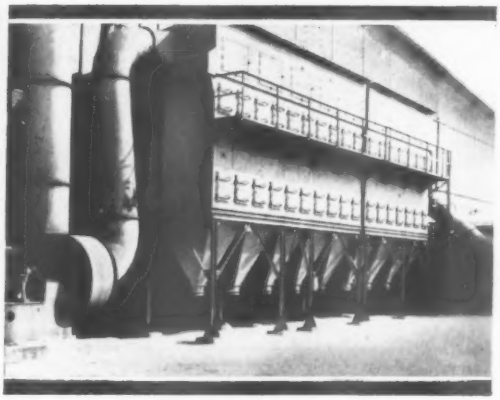

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FLEXHOISTA is made by a Company with close on a century of experience and service in ropes.*

* For scheduled replacement, emergency or just honest advice about wire ropes—call in Whitecross any time.

Fit the rope fit for the job—*fit*

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Advertisements (accompanied by a remittance) and replies to Box Numbers should be addressed to the Advertisement Manager, Foundry Trade Journal, John Adam House 17/19, John Adam Street, Adelphi, London, W.C.2. If received by first post Monday advertisements can normally be accommodated in the following Thursday's issue.

SITUATIONS WANTED

FOUNDRY SUPERINTENDENT/METALLURGIST (42), returning to U.K. from South Africa, towards end of October seeks position in either Grey Iron and/or Malleable Foundry as Foundry Technician or Metallurgist. All replies will be acknowledged. Box FS824, FOUNDRY TRADE JOURNAL.

FOUNDRY Technical and Commercial Manager requires potential directorship or partnership in business requiring new life, methods, or connections. Midlands preferred. Some capital available. Box FT847, FOUNDRY TRADE JOURNAL.

STEEL FOUNDRY METALLURGIST, 35, A.I.M., 16 years' wide experience laboratory work, foundry practice, arc, induction, open hearth melting, seeks position including responsibility for steel production. Box ST844, FOUNDRY TRADE JOURNAL.

SENIOR FOUNDRY FOREMAN, A.M.I.B.F., requires similar position. Wide experience in jobbing foundries and mass production on mechanised lines of both iron and steel castings. Used to working on own initiative and controlling all types of labour. Midlands or South Wales area preferred. Assistance with housing would be required. Box SF844, FOUNDRY TRADE JOURNAL.

INDUSTRIAL EXECUTIVE, 28, thoroughly experienced management foundry, sales, production, seeks Northern England post offering scope in engineering or founding. Exceptional record salesmanship, contracts, public relations. Salary secondary consideration to chance to exploit initiative, qualifications, experience. Box IN842, FOUNDRY TRADE JOURNAL.

TECHNICAL REPRESENTATIVE with foundry experience wishes to represent a Foundry for cast-iron and non-ferrous castings. Has personal connections in London and Home Counties. Part expenses and commission. Box TR840, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

NON-FERROUS FOUNDRY MANAGER required for South West Wales. Must have good practical and commercial experience. Excellent position with prospects for keen, energetic person. Room for considerable expansion. Superannuation scheme. Full details of experience, salary required, etc. Box NF838, FOUNDRY TRADE JOURNAL.

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SITUATIONS VACANT—*contd.*

SKILLED JOBBING MOULDERS required for Iron or Aluminium. Good working conditions and attractive bonus scheme. Lodgings can be arranged. Apply: REGENTS FOUNDRY, Catherine Street, Macclesfield.

SCOTTISH FOUNDRY producing quality Steel Castings require AGENT for Birmingham and Midlands Area. Confidential replies should give fullest details including territory covered and other products carried. Box SF835, FOUNDRY TRADE JOURNAL.

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SITUATIONS VACANT—*contd.*

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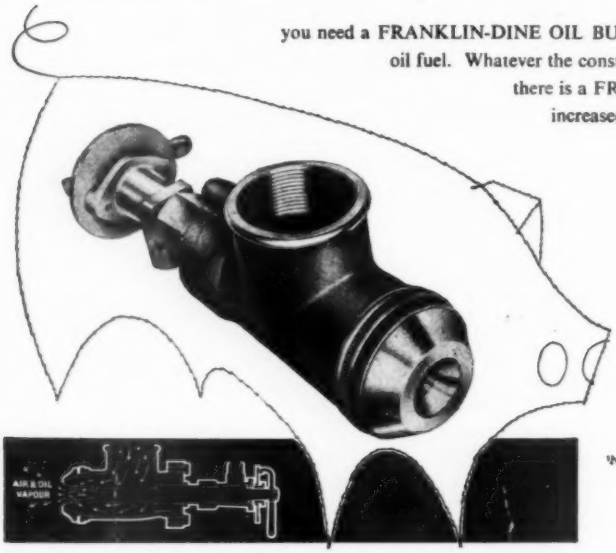

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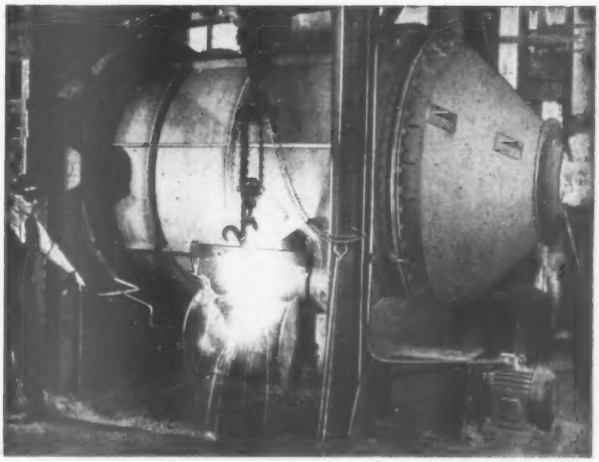

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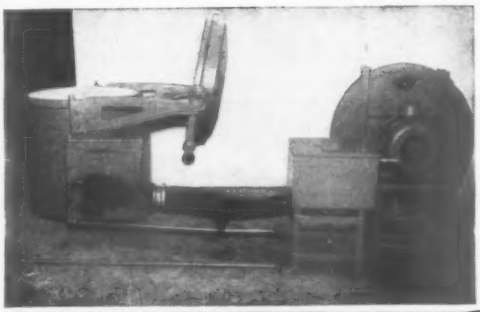

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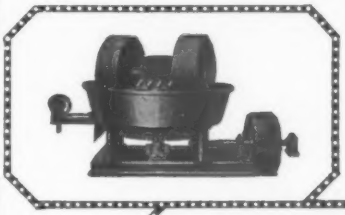

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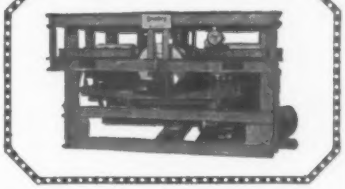

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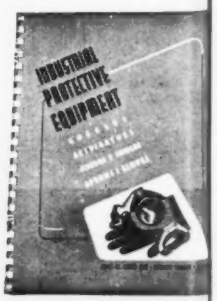

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